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Income Elasticity of Demand for Cigarettes: A Cross-Section Analysis

By S. M. Sackrin [1]

Empirical investigations seeking to determine the income elasticity of demand for cigarettes in the United States have been few, and have been based chiefly on time-series data. Their findings have been in general agreement, showing the income elasticity to be about 0.5 or 0.6. This article describes an investigation based on a cross-section approach using data from a recent survey of the Bureau of the Census on smoking characteristics in relation to income and other factors. A feature of this investigation is the disaggregation of demand data by age and sex. The income elasticity of demand for cigarettes obtained from this analysis is indicated to be lower than found by earlier investigators. These results are compared with those of previous studies, and some reasons are advanced for the differences.

RESEARCHERS GENERALLY find the derivation of reliable estimates of income elasticities of demand more troublesome than the derivation of price elasticities. Estimates of income elasticities are most frequently derived from aggregate time-series data. The principal drawback of this method has been that in such analyses no allowance is made for the changes in weights that determine the true parameters, such as changes in the distribution of income or the composition of population.

Recent contributions to the field of demand analysis stress the concept of aggregate or market elasticities as the sum of weighted averages of individual (or family) elasticities.[2] Some economists maintain that income elasticities cannot be measured accurately from aggregate time series data and that such coefficients should be derived from family budget data, as sample surveys are often called. The cross-section approach, as contrasted with the time-series approach, holds constant such demand factors as price, income level and distribution, and taste preferences. It avoids many of the difficulties stemming from the aggregation inherent in the time-series approach.

Source of Data

Each month the Bureau of the Census conducts its Current Population Survey to collect information on employment and related data. In its February 1955 survey, through arrangement with the

[1] Acknowledgment is made to Richard J. Foote and Arthur G. Conover, both of the Agricultural Economics Division, AMS, for helpful suggestions. The research on which this article is based is being carried on under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

[2] See in particular THEIL (7). Throughout this article, italic numbers in parentheses refer to Literature Cited, p. 9.

United States Public Health Service, the Bureau included a special schedule designed to gather data on smoking habits. The survey was conducted with a representative sample of about 40,000 civilian, noninstitutional persons in 230 sample areas, covering about 450 counties and independent cities scattered throughout all regions of the country.

In April 1955, income data were collected from three-fourths of the households in the sample. Approximately half of the February and April samples represented identical households. This made possible the cross-classification of information regarding smoking and income for individuals 18 years old and over.

The smoking information includes smoking status, product(s) smoked, and rates of smoking, as of the time of the survey, cross-classified with income by each of the following: Age, region, urban-rural residence, occupation, and industry. In the case of cigarettes, separate tabulations were made for male and female smokers. Income was 1954 personal money income, before taxes and occupational deductions.

Variables Used

In the measurement of income elasticity using a cross-section approach, factors other than income that affect consumption must be held constant from income class to income class. Besides income, cigarette consumption of an individual is affected by age, sex, regional location, urban or rural residence, and occupation, among other factors.

Price, of course, is a factor, although some earlier studies have indicated that it may be less important than income. Differences in cigarette prices are sizable, depending not only on the kind of cigarette (regular, king-size, filter-tip) but also on the existence of State and other local taxes. No price information is available from survey data, so that price cannot be explicitly introduced as a variable. However, the averaging of consumption among the various income and age groups on a national basis undoubtedly tends to reduce price differences.

Of the other factors enumerated, analysis of survey data indicates that age and sex are most influential in affecting cigarette consumption. Hence, in developing consumption functions, age was explicitly introduced as an independent variable and separate analyses were made for male and female smokers. Apart from considerations of selecting the most dominant factors that affect cigarette consumption, the nature of available data (tabulated only in two-way classifications for each sex) makes it impossible to consider more than two determining variables in a single analysis.

Analysis of Consumption-Income Relationship for Male Smokers

Table 1 shows average daily consumption of cigarettes, average income after Federal income taxes, and average (weighted mean) age of males who smoke regularly, classified in 6 age and 7 income classes. (The derivation of these data is described in a note at the end of this article.) A least-squares regression was computed, using average daily consumption as the dependent variable (X_1), and as the independent variables the following: X_2—average income divided by 100 (dollars), and X_3—the square of the deviation of the individual weighted mean age from 40, divided by 100 (years). A parabolic formulation was used for the age variable, since the survey data show that regardless of income the cigarette smoking rate among males tends to increase with age up to 35–44, and then to decline steadily among older age groups.[3] Since six different age groups usually were included in each income class, intercorrelation between income and age was nearly zero. X_1 and X_2 were expressed in logarithms; actual values of X_3 were used.

The following regression equation and statistical coefficients were obtained. Numbers in parentheses beneath the regression coefficients are their respective standard errors.

$$\underset{}{\text{Log } X_1'} = \underset{}{1.2504} + \underset{(0.0073)}{0.0674} \log X_2 - \underset{(0.0009)}{0.0117} X_3 \quad (1)$$

$$R^2_{1.23} = 0.89 \; r^2_{12.3} = 0.71$$

$$s_{1.23} = 0.0171 \; r^2_{13.2} = 0.83$$

Results are shown graphically in figure 1.

[3] The use of average age as an independent variable in addition to the squared term relating to age yielded a regression coefficient that did not differ significantly from zero. For this reason and the fact that its inclusion did not increase the coefficient of multiple determination, this variable was dropped from the analysis.

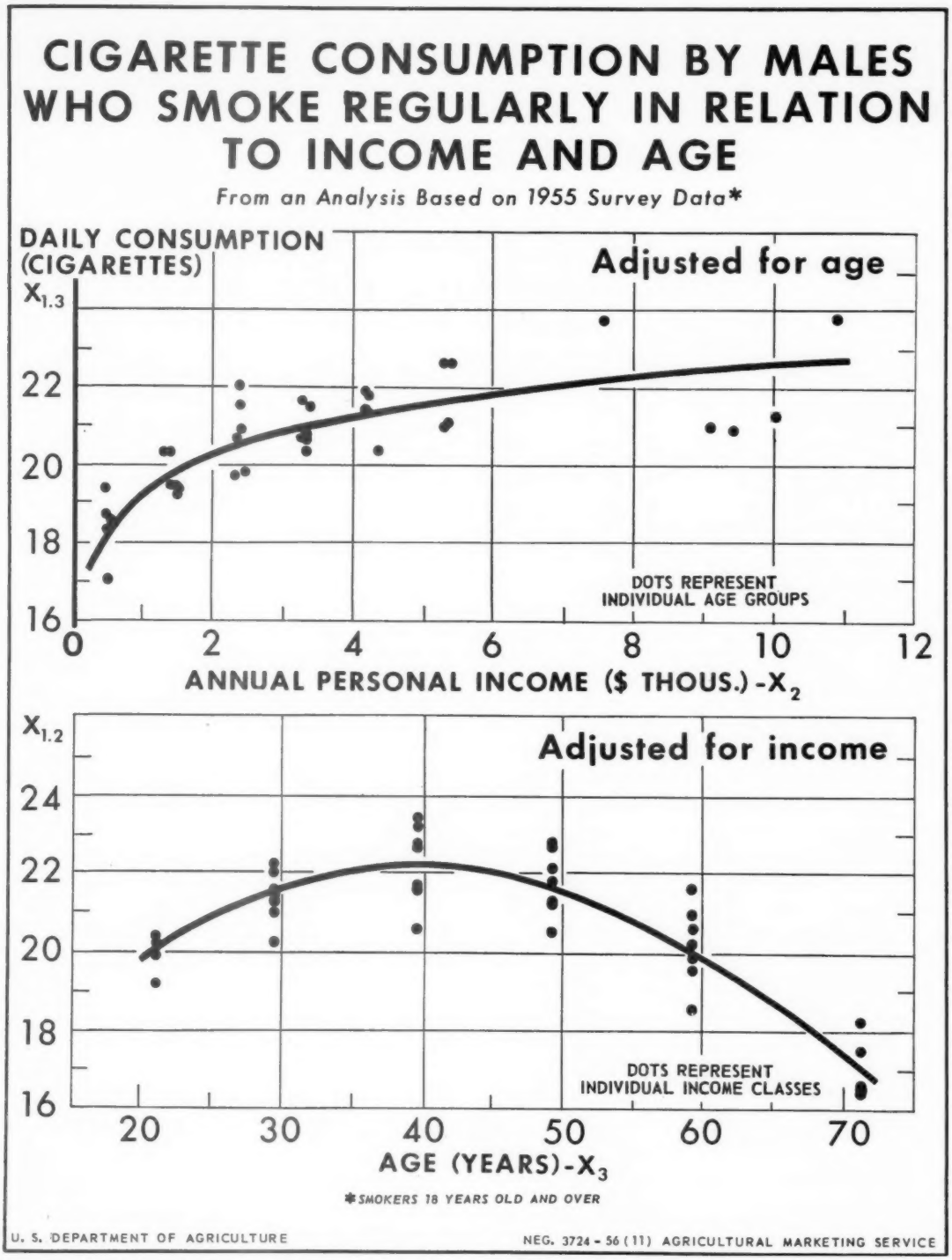

FIGURE 1.—Cigarette consumption by males tends to increase with increasing income, after adjusting for the effect of age, but the rate of increase is larger for the smallest incomes. In relation to age, consumption increases up to about age 35, remains relatively stable through age 45, and then declines, after adjusting for the effect of income.

TABLE 1.—*Males, 18 years and over, who smoke cigarettes regularly: Average daily consumption of cigarettes and average annual income, by age and income class, February 1955*

Item for specified age group [1]	Income class [2]						
	Under $1,000	$1,000–$1,999	$2,000–$2,999	$3,000–$3,999	$4,000–$4,999	$5,000–$6,999	$7,000 and over
Consumption:	*Cigarettes*	*Cigarettes*	*Cigarettes*	*Cigarettes*	*Cigarettes*	*Cigarettes*	*Cigarettes*
18–24 (20.9)	18. 2	19. 1	20. 2	20. 2	[3] 19. 9	([4])	([5])
25–34 (29.5)	19. 2	20. 4	21. 9	21. 8	22. 9	22. 0	22. 0
35–44 (39.4)	20. 9	20. 9	21. 5	23. 2	23. 5	24. 4	22. 5
45–54 (49.1)	19. 7	20. 4	22. 7	21. 7	22. 5	23. 8	22. 5
55–64 (59.2)	16. 6	19. 8	21. 5	20. 2	20. 9	20. 6	23. 2
65 and over (71.3) [6]	14. 9	16. 8	16. 3	16. 9	[7] 19. 6	([4])	([4])
Income: [3]	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
18–24 (20.9)	564	1, 418	2, 363	3, 271	[3] 4, 341	([4])	([5])
25–34 (29.5)	549	1, 451	2, 418	3, 318	4, 179	5, 302	9, 117
35–44 (39.4)	496	1, 498	2, 427	3, 325	4, 191	5, 327	9, 418
45–54 (49.1)	473	1, 480	2, 414	3, 302	4, 207	5, 296	10, 012
55–64 (59.2)	527	1, 449	2, 417	3, 302	4, 175	5, 352	10, 913
65 and over (71.3) [6]	580	1, 397	2, 335	3, 302	[7] 7, 597	([4])	([4])

[1] Figures in parentheses are the respective average (weighted mean) age for the class, in years.
[2] 1954 personal money income, less Federal income tax.
[3] Includes those receiving $4,000–$6,999.
[4] Combined with $4,000–$4,999 class.
[5] No persons in sample.
[6] Average age includes those up to age 85.
[7] Includes those receiving $4,000 and over.

The signs obtained from the analysis are consistent with expectations, that is, consumption of cigarettes among males increases with income, after allowing for the effects of age, and decreases with the difference in age from 40 (taken as the age of peak smoking rate), after allowing for the effects of income. Since X_1 and X_2 are expressed in logarithms, the regression coefficient $b_{12.3}$ directly measures the income elasticity of demand.[4] The indicated income elasticity of 0.07 is small but differs significantly from zero.

[4] The proof of this follows, where Q equals consumption, I equals income, and Z equals age:

$$\text{Log } Q = a + b_{11} \log I + b_{12} Z$$

$$\frac{1}{Q}\frac{\partial Q}{\partial I} = \frac{b_{11}}{I}$$

$$\frac{\partial Q}{\partial I} = \frac{b_{11} Q}{I}$$

Substituting in the general formula to determine elasticity of demand $\left(\eta = \frac{dy}{dx} \cdot \frac{x}{y}\right)$:

$$\eta_I = \frac{b_{11} Q}{I} \cdot \frac{I}{Q} = b_{11}$$

Both age and income appear to be influential factors accounting for the variation in the cigarette smoking rate of males, but of the two, age may be somewhat more important.

The regression coefficient $b_{13.2}$ implies the following percentage changes in daily smoking rates of males, after allowing for the effects of income:

Age	Percentage change from preceding age	Age	Percentage change from preceding age
Years	*Percent*	*Years*	*Percent*
20		50	−2. 0
25	4. 8	55	−3. 3
30	3. 4	60	−4. 6
35	2. 1	65	−5. 9
40	. 7	70	−7. 1
45	−. 7		

These data indicate that when income is held constant the largest increase in rate of cigarette smoking among males occurs between the ages of 20 and 30, and that the maximum smoking rate is attained by about age 35, with little change thereafter through age 45. On the other hand, the net relationship indicates that after 45 the quan-

tity smoked daily declines with age at an accelerating rate. By age 70, the average daily smoking rate is about a fifth less than the peak rate averaged by those 35–45, after allowing for the effect of income.

To learn whether income elasticities varied by age, simple regressions were computed for each of the six age groups among the male regular smokers, using data shown in table 1. By means of separate analyses, age in effect is held constant and the relationship between consumption and income is examined. Results from these analyses are shown in table 2. Regression coefficients and coefficients of determination differ significantly from zero at the 5-percent probability level for all analyses except those for male smokers aged 35–44, which are significant at the 6–7 percent level. While the coefficients of determination do not differ from each other by a statistically significant amount for the small number of observations involved, other survey data tend to confirm the relative magnitudes. Differences in income do not account for as high a proportion of variation in cigarette consumption among male smokers 25–54, especially those 35–44, as they do for other age groups. Among men 25 to 54 are found both the largest proportions of regular cigarette smokers and the heaviest smokers, with relatively little variation in smoking rates from income class to income class.

TABLE 2.—*Statistical results from regression analyses of the relation between cigarette consumption and income of male regular smokers, by age*

Age group (years)	Regression coefficient [1]	Standard error of regression coefficient	Coefficient of determination
18–24	0.052	0.012	0.85
25–34	.056	.014	.76
35–44	.046	.019	.54
45–54	.056	.016	.70
55–64	.096	.020	.83
65 and over	.095	.022	.86

[1] Both variables were expressed in logarithms; hence the regression coefficient b_{12} directly indicates the income elasticity.

Derived income elasticity coefficients range from about 0.05 among those 18–54 to 0.10 among those 55 and over. Coefficients for the four age groups 18–54 do not differ significantly from each other, but do differ significantly from the higher coefficients for those 55 and over. This implies that cigarette consumption by male smokers 55 and over is somewhat more responsive to income changes than in the case of younger men. If we weight by the respective average consumption of regular smokers in each age group, the average of the individual elasticities is 0.07, which equals that found by analysis of the pooled observations.

Analysis of Consumption-Income Relationship for Female Smokers

Pooled data of table 3 were used in a least-squares regression analysis of cigarette consumption of female regular smokers in relation to income and age. X_1 and X_2 represent the same variables as in the preceding analyses, namely, average daily consumption (cigarettes) and average income adjusted for Federal income taxes (dollars), respectively. X_3 represents average age and X_4 the square of the deviation of average age from 49, the mean of the 45–54 age interval, in which the peak smoking rate at first appeared to exist. No variables are expressed in logarithms, but both X_2 and X_4 were coded by dividing by 100. The following regression equation and statistical coefficients were obtained:

$$X_1' = 17.82 + \underset{(0.02)}{0.02}\, X_2 - \underset{(0.02)}{0.08}\, X_3 - \underset{(0.10)}{0.50}\, X_4 \qquad (2)$$

$$R^2_{1.234} = 0.69 \quad r^2_{12.34} = 0.04 \quad r^2_{14.23} = 0.60$$

$$s_{1.234} = 1.21 \quad r^2_{13.24} = 0.58$$

The regression coefficient on income, although of correct sign, does not differ from zero by a statistically significant amount. This result was not altogether unexpected, since survey income data for female smokers represent personal income and hence are an inadequate measure of their true purchasing power because of husbands' or other family income. While income data relating to male smokers also may not fully reflect true purchasing power, access to other family income probably is less important than in the case of employed females.

Residual variance from the curve of net consumption-age relationship is considerably greater than was observed in the analysis of male smokers, but the net relationship suggests a similar ef-

TABLE 3.—*Females, 18 years and over, who smoke cigarettes regularly: Average daily consumption of cigarettes and average annual income, by age and income class, February 1955*

Item for specified age group [1]	Income class [2]			
	Under $1,000	$1,000–$1,999	$2,000–$2,999	$3,000 and over
Consumption:	*Cigarettes*	*Cigarettes*	*Cigarettes*	*Cigarettes*
18–24 (21.1)	10. 9	12. 8	12. 1	14. 4
25–34 (29.5)	13. 4	14. 6	13. 8	15. 2
35–44 (39.4)	15. 5	12. 4	13. 5	14. 5
45–54 (49.3)	14. 6	14. 7	14. 9	15. 7
55–64 (59.2)	14. 1	[3]	10. 8	[3]
65 and over (71.7) [4]	10. 6	10. 5	8. 5	10. 7
Income: [2]	*Dollars*	*Dollars*	*Dollars*	*Dollars*
18–24 (21.1)	504	1, 441	2, 327	3, 368
25–34 (29.5)	453	1, 429	2, 348	3, 529
35–44 (39.4)	470	1, 459	2, 350	3, 744
45–54 (49.3)	457	1, 452	2, 352	3, 889
55–64 (59.2)	483	[3]	2, 433	[3]
65 and over (71.7) [4]	514	1, 377	2, 295	5, 262

[1] Figures in parentheses are the respective average (weighted mean) age for the class, in years.
[2] 1954 personal money income, less Federal income tax.
[3] Too few cases in sample.
[4] Average age includes those up to age 85.

fect of age on smoking rates. The greatest gains in smoking rates of women smokers also appear to occur between the ages of 20 and 30 and the maximum smoking rate is attained by about age 35. However, because of greater residual variance, the age of the peak smoking rate among women is not as clearly defined as among males. It occurs apparently sometime between the ages of 35 and 50.

Analysis of Consumption-Income Relationship for All Regular Smokers

Earlier studies attempting to estimate the income elasticity of demand for cigarettes were concerned with the demand of all smokers. To derive an income elasticity coefficient which can be compared with those obtained in previous studies, the proper procedure is to combine the income elasticities relating to male and female smokers, respectively, on a weighted basis. In the present instance, however, this cannot be done because of the lack of a valid estimate relating to female smokers. As an alternative, cigarette consumption of male and female smokers each was adjusted for the effects of age, based on the foregoing analyses. The adjusted consumption data then were combined on a weighted basis and a weighted simple regression computed on income, with number of smokers in each cell used as weights. The following regression equation and statistical measures were obtained. X_1 represents average daily consumption, cigarettes; X_2 represents average income, less Federal income taxes, coded in 100 dollars.

$$\text{Log } X'_1 = 1.12 + \underset{(0.01)}{0.12} \text{ log } X_2 \qquad (3)$$

$$r^2_{12} = 0.78,\ s_{12} = 0.022$$

The indicated income elasticity of 0.12 for all regular smokers also is small, but differs significantly from zero.[5] The slope of the consumption-income curve is steeper than in the case of male smokers only. This arises from the fact that women smokers, characterized by smoking rates averaging about a third less than those among males, are concentrated in income classes of $3,000 and less, whereas males predominate in the higher income classes. Graphically, the appearance of the consumption-income curve for all regular cigarette smokers is very similar to that for male smokers shown in the top section of figure 1.

[5] An unweighted simple regression using the same variables yielded a regression coefficient (income elasticity) of 0.11±0.01. Computation of the income elasticity by the short-cut method presented in WOLD AND JUREEN (*11*, p. 216) yielded a coefficient of 0.12.

Other Estimates of the Income Elasticity of Demand for Cigarettes

The elasticity coefficient on income of 0.12 is smaller than that found by other investigators using a time-series approach or, in one instance, cross-section analysis. A study made by the United States Treasury Department in 1948 mentioned a statistical analysis relating cigarette consumption to price, income, and trend in the years 1929–43. The income elasticity was indicated to be larger than the price elasticity of approximately −0.10, although neither any specific figure nor any details of the analysis itself were given (*10*, p. 15). In a study published by the Federal Reserve Bank of Richmond in 1952, per capita cigarette consumption was related to real price, per capita real disposable income, and trend in the years 1929–48. This analysis indicated a price elasticity of −0.66 and an income elasticity of 0.59 (*1*, pp. 28–31). However, results of this study are open to some question because of the inadequacy of the price data utilized and the high intercorrelation between income and time. In an unpublished study based on year-to-year changes in national time series data for 1927–41, George R. Rockwell, Jr., Agricultural Marketing Service, U. S. D. A., estimated the price elasticity of demand for cigarettes at around −0.3 and the income elasticity at 0.5. Using a geographic cross-section approach in analyzing data by States for each of the years 1947–51, Maier obtained coefficients of income elasticity of demand for cigarettes ranging from 0.29 (1948) to 0.60 (1951). He concluded that ". . . the income elasticity of demand for cigarettes during periods of high incomes and little unemployment appears to be somewhere around +0.5." (*4*).

Reasons for Differing Elasticity Estimates

Income elasticities derived from family budget data may be regarded as long-term elasticities, as are elasticities derived from market statistics.[6] If this is so, why are there differences between elasticities obtained from time series or market data and family budget data? The literature is not very definite on this point. Theil (*7*, p. 181) states ". . . the relation between time series and cross-section studies is a difficult subject requiring further analysis", although he does suggest in his book some methods which in principle, at least, would indicate the kind of interrelationships expected. Wold and Jureen (*11*, p. 229) attempt to answer the question but caution the reader as follows: "The conclusions arrived at in the general remarks ventured below should . . . be regarded as tentative."

Although no attempt is made here to account fully for the differences, in general the varying elasticities obtained by the two methods may be due to the following:

(1) In time-series analysis, it is not possible completely to account for all the dynamic elements that influence demand, such as changes in distribution of income, composition of population, and consumer tastes. Introduction of time as a separate variable or the use of first differences are not complete solutions to these difficulties. Moreover, as Theil points out, macroparameters (those relating to aggregated individuals or families or market data) are basically weighted averages of microparameters (those relating to individuals or families). Time-series analysis using aggregate data fails to take recognition of changing weights, such as individual income and population composition. As a result it is possible to derive changing macroparameters even though the underlying microparameters remain constant. Under such circumstances, "different statistical methods yield estimates of different macroparameters because the weights implied by the use of different methods vary from one method to another."[7] Consistent results are obtained from time-series or cross-section analysis if the microparameters are weighted properly to derive an average.

(2) A permanent change in consumer habits may mean that demand will expand with rising incomes but will not fall correspondingly with reduced incomes. If a commodity is thus characterized by an "irreversible demand function," a decrease in incomes among families over time is accompanied by changes in demand differing from those implied by budget data elasticities.[8]

[6] See Wold and Jureen (*11*, pp. 227–228). A similar point is made by Prais and Houthakker (*5*, p. 12).

[7] Theil, H., *op. cit.*, p. 135.

[8] A brief account of this concept, based on the contributions of Modigliani, Duesenberry, and Farrell may be found in Wold and Jureen (*11*, p. 228), and Stone (*6*, pp. 271–272).

(3) Changes in demand over time may be partly attributable to the introduction and availability of new types or brands of commodity, as well as to the usual determining factors such as price and income. This complication does not appear in the static situation of the budget or cross-section approach.

More specifically, time-series analysis of aggregate cigarette consumption in relation to national levels of disposable income undoubtedly is affected by the extreme changes in both variables that occurred during the economically depressed years of the 1930's. The effects of increased smoking by women and younger individuals, coincident with rising national income, may not be completely accounted for by a time trend.[9]

Errors of observation also may account for some of the differences in estimates of elasticity. The census survey data fail to account for aggregate national consumption of cigarettes, falling short by approximately 10–15 percent, even after allowance for uncovered groups such as smokers under 18 years of age, members of the Armed Forces, and institutional inmates. This bias is typical of consumer surveys, in which reported expenditures for or consumption of alcoholic beverages and tobacco are generally understated.[10] Unless this bias is uniform from income class to income class, income elasticities derived from census survey data could be underestimated. Use of personal rather than family income data undoubtedly is also a shortcoming.

In view of these difficulties, it is not surprising that the estimate of income elasticity of demand for cigarettes derived from census survey data differs from those obtained from time-series data. Although Maier's estimates are based on a geographic cross-section analysis, the income data he used represented average income within a State and did not consider its distribution among families.

Despite the limitations of census survey data, the income elasticity derived from the analysis is probably closer to the true parameter than are the other estimates. The lower level of the estimate is in agreement with the statement of Wold and Jureen (*11*, p. 230): "The income elasticities of family budget data on the whole tend to be smaller than the income elasticities that refer to market statistics."

The differing estimates of income elasticities obtained by use of the two methods emphasize the need for additional work in this area. Greater recognition should be given to the possibility of deriving estimates of income elasticity of demand from family budget data, particularly by splitting the data into reasonably homogeneous subgroups and pooling the results by means of proper weights to derive an estimate of aggregate or market elasticity.

Note on Derivation of Data

Survey data on daily cigarette smoking rates were presented in the form of frequency tables, containing four classes as follows (cigarettes): 1–9, 10–20, 21–40, over 40. A midvalue for each class was computed, using a special census tabulation showing consumption for each age group by single cigarettes. These midvalues were then weighted by the respective proportions of those smoking regularly at each rate to obtain a weighted average daily consumption for each cell.

A weighted average age for each age group was computed from 1950 Census of Population data, showing population by single years of age (*8*, p. 165). These data were adjusted to the age distribution of the population as of July 1, 1954 (*9*).

The income data with which smoking information was cross-classified also were shown in terms of class intervals, mostly $1,000 in size. A mean for each interval was calculated, using formulas to approximate averages in the intervals of a distribution. [See Liebenberg and Kaitz (*3*, pp. 442–445).] These data were adjusted for Federal income taxes, using Department of Commerce data on average rates. [See Goldsmith (*2*, p. 15).] Adjustment could not be made for local taxes and occupational deductions, but these are small compared with the Federal income tax. The principal limitation of these income data is that

[9] Another minor source of difference is the fact that the analysis of census survey data related to regular smokers only (those smoking each day), and omitted the occasional smokers. Consumption of the latter group is included in the aggregate data used in time-series analysis. However, occasional cigarette smokers (male and female), while comprising nearly 10 percent of the total cigarette smoking group, probably account for less than 1 percent of aggregate consumption.

[10] See, for example, PRAIS *and* HOUTHAKKER (*5*, pp. 41–42).

they represent personal income, and may not be a complete measure of an individual's purchasing power. This limitation operates to some extent for men (because of other family income), but it is particularly significant for employed married women, as in most instances their husbands' income exceeds their own.

Literature Cited

(1) Federal Reserve Bank of Richmond, Research Department.
1952. FLUE-CURED TOBACCO, AN ECONOMIC SURVEY. 170 pp., illus.

(2) Goldsmith, Selma F.
1956. INCOME DISTRIBUTION IN THE UNITED STATES, 1952–55. Survey of Current Business, 36: 6: 9–16, illus.

(3) Liebenberg, Maurice, and Kaitz, Hyman.
1951. AN INCOME SIZE DISTRIBUTION FROM INCOME TAX AND SURVEY DATA, 1944. In National Bureau of Economic Research. Studies in Income and Wealth, Volume 13, pp. 379–462, illus. New York.

(4) Maier, Frank H.
1955. CONSUMER DEMAND FOR CIGARETTES ESTIMATED FROM STATE DATA. Jour. Farm Econ. 37: 690–704.

(5) Prais, S. J., and Houthakker, H. S.
1955. THE ANALYSIS OF FAMILY BUDGETS. 372 pp., illus. Cambridge, England.

(6) Stone, Richard.
1954. THE MEASUREMENT OF CONSUMERS' EXPENDITURE AND BEHAVIOUR IN THE UNITED KINGDOM, 1920–1938. Volume 1. 448 pp., illus. Cambridge, England.

(7) Theil, H.
1954. LINEAR AGGREGATION OF ECONOMIC RELATIONS. 205 pp., illus. Amsterdam.

(8) U. S. Bureau of the Census.
1953. SEVENTEENTH DECENNIAL CENSUS OF THE UNITED STATES: 1950. Volume II, Part 1, United States summary. 486 pp., illus. Washington, D. C.

(9) ———
1955. CURRENT POPULATION REPORTS. Series P–25, No. 121. Washington, D. C.

(10) U. S. Treasury Department, Division of Tax Research.
1948. FEDERAL EXCISE TAXES ON TOBACCO. 76 pp. Washington, D. C. (Processed.)

(11) Wold, Herman, and Jureen, Lars.
1953. DEMAND ANALYSIS: A STUDY IN ECONOMETRICS. 358 pp., illus. New York.

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Allocation of Net Farm Income

By Edgar B. Hurd

The problem of allocating farm income among the factors of production has long received the attention of agricultural economists. Progress toward a satisfactory solution has been impeded, both by difficult conceptual problems and by lack of adequate statistical data. In the following article, Mr. Hurd makes a new effort in the field of farm income allocation on the basis of a considerably better-than-average body of data, and a new conceptual approach. It is not expected that all readers will concur fully with his analysis. Problems are certain to be raised with respect to such questions as whether the value of inventory changes should be included in net farm income for allocation purposes; the inclusion of capital outlays in expenses deductible from gross income; and combining the return to labor and management. However, this paper does offer an approach to the problem that is both interesting and stimulating, and has the particular virtue of avoiding the unsatisfactory method of always treating the returns to one of the factors as a residual item.

THIS PAPER IS INTENDED to demonstrate various methods of allocating net farm income to unpaid factors of production. These factors of production include real estate (land and buildings), working capital (livestock, machinery, feeds, and seeds), and unpaid family and operator labor and management.

A satisfactory method of allocating net farm income has long been needed. How much of this income may be attributed to each of the unpaid factors? What are the rates of return per unit by factors? What is happening to these rates over time and how do rates in one area compare with rates in another area? How do the rates of return to factors of production used in agriculture compare with rates of return to factors of production used in other industries?

Even approximate answers to these questions would be helpful in (1) selecting an occupation, (2) management of individual farms, and (3) determination of agricultural policy. For answers to these and similar questions, a practical method of allocating net farm income is necessary. Some of the several methods suggested in this article have been used in past research in farm management. They are more or less standard. Other methods are new or new applications of old procedures and are therefore experimental.

Data used in this article came from a costs-and-returns study of average commercial family-operated wheat-pea farms of Washington and Idaho, made by the Production Economics Research Branch, Agricultural Research Service, United States Department of Agriculture in cooperation with the Washington and Idaho Agricultural Experiment Stations.[1] Data are available for each year from 1935 to 1955. The data and analyses are comparable from year to year and are adequate for the purposes outlined here. But, in order to apply the results obtained in that study, the definitions of the terms used should be understood.

Net farm income as defined in the present report is cash income exclusive of Government payments, plus the value of farm perquisites, and the value of the net change in inventories at year-end prices (table 1). Cash income is the difference between the total value of all farm products sold and cash expenditures. The latter consists of all cash paid during the calendar year for goods and services used in production, including cash paid for purchases of capital items such as machinery, equipment, service buildings, and fences.

Rent and interest payments and purchases of additional land are not included as costs. The farm share of the automobile is included. Included as costs are 50 percent of the automobile depreciation plus 50 percent of its operating costs involved in local travel. Taxes and repairs on real estate and working capital are included in cash expenditures. Government payments are usually included as a part of net farm income.

[1] For a description of the wheat-pea area and for many details affecting net farm income, such as size of farm, farm organization, crop yields, mechanization, farm practices, and prices, see HURD, EDGAR B. WHEAT-PEA FARMING IN WASHINGTON AND IDAHO, 1935–53. U. S. Dept. Agr. Cir. 954. 1955.

They are excluded here because they are not related to factors of production in terms of quantity and price as are the other components of net farm income.

The value of farm perquisites includes the value of the farm garden, the value of livestock and livestock products consumed by the farm family at current prices, and the net rental value of the farm dwelling. The net rental value is estimated as 8 percent of the current value of the dwelling.

The value of the change in inventories is computed by multiplying the difference in physical terms between the beginning and closing inventories of specified crops, livestock, machinery and equipment, and service buildings at their respective year-end prices. By this method, capital gains or losses are excluded from net farm income.

TABLE 1.—*Net farm income, and factors that receive net farm income, wheat-pea area of Washington and Idaho, 1935–55*

Year	Net farm income [1]	Factors that receive net farm income		
		Labor and management time at work	Real estate area	Working capital, 1947–49 prices
	Dollars	*Hours*	*Acres*	*Dollars*
1935	2, 288	2, 156	389	9, 005
1936	2, 850	2, 151	401	9, 972
1937	2, 618	2, 117	397	11, 703
1938	598	2, 121	410	13, 861
1939	1, 643	2, 094	421	15, 461
1940	1, 918	2, 090	426	16, 065
1941	4, 794	2, 063	427	17, 293
1942	11, 145	2, 051	426	16, 382
1943	11, 377	2, 041	440	19, 285
1944	11, 162	2, 002	453	16, 818
1945	9, 611	2, 002	444	17, 891
1946	14, 110	1, 956	457	18, 075
1947	15, 257	1, 977	476	19, 282
1948	11, 624	1, 995	474	18, 135
1949	8, 330	1, 987	494	19, 791
1950	9, 671	2, 002	482	18, 620
1951	10, 536	1, 981	498	19, 623
1952	14, 025	2, 016	507	19, 490
1953	14, 520	2, 230	512	21, 016
1954	16, 406	2, 300	524	21, 428
1955 [2]	10, 281	2, 300	536	22, 516

[1] See text for definition.
[2] Preliminary.

Net farm income then is the income that results from the use of three sets of factors: (1) Labor and management of the operator and his family, (2) real estate (land and buildings), and (3) working capital (livestock, machinery, and crops held for feed and seed, and for sale). These factors are referred to as unpaid factors because, as defined, no charge is made for their use except the cost of maintaining the real estate and working capital.

Several approaches may be used in allocating net farm income to the factors of production. Each method has its advantages and its shortcomings. One approach is to assume that the return to family labor and management is the part of the net farm income that remains after the return to the current value of capital at the going rate of interest is deducted.

This assumption, however, is not realistic. Most farmland is only partially mortgaged and most working capital is owned free of debt. The landowner and the farm operator expect to recover investment costs with interest over a period of years, but they expect their returns to vary from year to year with the variation in net farm income. The latter varies greatly and is unpredictable.

Second approach is to assume that the return to capital is the part of the net farm income that remains after the return to the family for labor and management at hired labor rates is deducted. The difficulty with this approach lies in determining what the family labor and management services would command if offered for sale. The amount and effectiveness of many of these services vary greatly from farm to farm. Some of them have no alternative uses. Further, it is generally recognized that the returns actually realized from family labor and management vary from the market returns as measured by hired labor rates.

In corporation accounting, where all labor and management is hired, net income is attributed to capital. In most farm-management studies, net farm income is usually allocated to real estate and working capital on the basis of their current value times the going interest rate. The labor and management of the family is thus left as a residual claimant or, as stated above, the value of family labor and management at market prices is estimated and capital is left as the residual claimant.

The purpose of such accounts is chiefly to compare the efficiency in use of resources associated with different farming systems and practices on individual farms in areas where other production

conditions are reasonably similar. Somewhat different problems are involved in comparisons of incomes from a group of farms through time, or in comparing incomes in agriculture in one area with those in other industries or areas.

One approach to the problem of how to allocate net farm income, which is suggested for consideration here, is to assume that returns in a given year are shared by real estate, working capital, and family labor and management in proportion to their longer run or normal opportunity costs, or their contribution to net income. This would mean that (1) in a period in which resources used in agriculture earn returns comparable to returns in other industries, (2) or in a period when on the average there is no economic incentive to increase or decrease the size of the farm or to add or subtract working capital on the average farm, each factor earns a return equal to its opportunity costs. In prosperous years, each factor returns, in addition to its normal costs, a share of the profits. In depression periods, each factor shares the losses.

The purpose of this article is to present some empirical tests of the merits of these alternative methods of allocating net farm income to its component factors for a series of years in a simplified situation. In this way, some alternatives may be suggested for developing more adequate methods of procedure.

Measuring the Quantities of the Unpaid Factors

Measuring the quantity of each of the unpaid factors used on the farm in a given year is relatively easy. Real estate may be measured by the number of acres per farm. As this analysis deals with the average farm, it follows that the acres per farm are always of average quality.

The amount of family labor and management (the nonmaterial resources of the family) may be measured by the hours of family labor employed at farmwork. The size of the average farm family, its age, and its sex distribution have not changed materially in the last 25 years. Nor has the potential productivity of the human factor varied greatly from one year to the next.

The measurement of the physical quantities of working capital is more difficult because of (1) the diversity of the items that constitute working capital, and (2) the change over time in the relative composition of these items. A frequently cited example of the latter is the decrease in numbers of draft horses relative to the increase in numbers of tractors.

The problem of how to measure the quantity of working capital despite its changing composition may be resolved by using the 1947–49 average price per unit of each kind of working capital as a common denominator.[2] The amount of working capital was taken as the quantity in the January 1 inventory. Multiplying the quantity of each item of working capital in a given year by its respective average price during 1947–49 and summing these products give a physical measure of the working capital for that year. The only way in which this measure can change from one year to the next is by changing the quantities of capital items, as the common denominator 1947–49 price has been held constant.

After each unpaid factor has been measured in physical terms, the next step in the procedure is to obtain a common denominator or physical measure for acres of land, hours of labor, and dollars' worth of working capital. This common measure is called an input. The method of computing this measure is similar to that used in measuring the quantity of working capital at 1947–49 prices.

The average cost (1947–49) per physical unit of each factor is its ability to produce income. These average costs are based on alternative opportunities for producing income in the period 1947–49. For example, if loaned out at intermediate credit rates in the period 1947–49, capital earned 5.3 percent. Consequently, the input per $1.00 of working capital at 1947–49 prices is 0.053.

An acre of real estate on these wheat-pea farms was valued at $175 on 1947–49. If the farm owner had sold his land at this price and had invested his money in long-term real estate mortgages that were yielding 4.6 percent, he would have realized $8.05 per acre ($175 × .046). The input per acre of land is therefore 8.05.

The average wage paid by farmers per hour for labor without board or room during the period 1947–49 was $0.956. If, instead of farming for himself, the farm operator had worked at hired man's wages, he would have earned $0.956 per

[2] These prices were used because they had been computed for another purpose. Probably a set of prices based on all years of record would be more appropriate here.

TABLE 2.—*Net farm income* [1] *and the composition of factors that share in net farm income*

Year	Unpaid inputs [2]	Net farm income [1]		Distribution of inputs			Total
		Total	Per input [2]	Family labor	Real estate	Working capital	
	Number	*Dollars*	*Number*	*Percent*	*Percent*	*Percent*	*Percent*
1935	5, 669	2, 288	0. 404	36	55	9	100
1936	5, 813	2, 850	. 490	35	56	9	100
1937	5, 840	2, 618	. 448	34	55	11	100
1938	6, 063	598	. 099	34	54	12	100
1939	6, 210	1, 643	. 265	32	55	13	100
1940	6, 278	1, 918	. 306	32	55	13	100
1941	6, 326	4, 794	. 758	31	54	15	100
1942	6, 258	11, 145	1. 781	31	55	14	100
1943	6, 515	11, 377	1. 746	30	54	16	100
1944	6, 452	11, 162	1. 730	30	56	14	100
1945	6, 436	9, 611	1. 493	30	55	15	100
1946	6, 507	14, 110	2. 168	29	56	15	100
1947	6, 744	15, 257	2. 262	28	57	15	100
1948	6, 684	11, 624	1. 739	29	57	14	100
1949	6, 926	8, 330	1. 203	28	57	15	100
1950	6, 781	9, 671	1. 426	28	57	15	100
1951	6, 943	10, 536	1. 517	27	58	15	100
1952	7, 041	14, 025	1. 992	27	58	15	100
1953	7, 368	14, 520	1. 971	29	56	15	100
1954	7, 553	16, 406	2. 172	29	56	15	100
1955 [3]	7, 707	10, 281	1. 334	29	56	15	100

[1] Excludes Government Payments.
[2] Inputs that share in net farm income valued at 1947–49 average prices.
[3] Preliminary.

hour. The input for one hour of family labor and management is therefore 0.956.

Quantities of all the unpaid factors used in production from 1935 through 1955 have been summed into total inputs (table 2). This was done by multiplying the quantity of each factor shown in table 1 by its respective input per year. This procedure is illustrated for the year 1935 as follows:

Factor	Quantity	Inputs in 1947–49 dollars	
		Per unit	Total
	Hours	*Number*	*Number*
Family labor	2, 156	0. 956	2, 061
	Acres		
Real estate	389	8. 05	3, 131
	Dollars		
Working Capital [1]	9, 005	. 053	477
Total			5, 669

[1] Working capital based at 1947–49 dollars.

One input is $1.00 of cost at 1947–49 prices. One dollar at 1947–49 prices will buy 1.046 hours of labor (1.00÷0.956). It will buy the use for 1 year of 0.124 acre of land (1.00÷8.05). It will buy the use for 1 year of $18.87 worth of capital (1.00÷0.053). One input is therefore 1.046 hours of labor, 0.124 acre-years of land, or the use for 1 year of $18.87 worth of capital at 1947–49 prices.

Distribution of Inputs and Rate of Return per Input

Dividing the net farm income by the total inputs of the unpaid factors gives the rate of return per input. This rate multiplied by the total inputs supplied by each of the unpaid factors gives the allocated income to the total of each factor. This method of allocating net farm income is called "the imputed method" in this paper. By this method the income per unit of unpaid inputs varies by years, depending on the ratio of net farm income to total inputs. But the income per unit of input is the same for each of the unpaid factors in a given year.

From 1935 to 1955, the inputs of the unpaid factors averaged $6,555 and net farm income averaged $6,581.[3] That is, each input received an income on the average of about $1.00. With minor exceptions, the trend in the number of inputs per year has been steadily upward at an average rate of 1.3 percent per year (fig. 1). The index of unpaid inputs (1935–55=100) was 86.5 in 1935 and 117.6 in 1955. The index of net farm income (1935–55=100) varied from a low of 10 in 1938 to a high of 217 in 1954. From 1935 to 1955, the average variation in net farm income amounted to 117 percent. This contrasts with a variation in unpaid inputs of 7 percent.

[3] Computed on the basis of the geometric mean.

It is evident, therefore, that most of the variation in net farm income is reflected in the variation of returns per unit of unpaid factor. This is particularly true in the short run and it is true to a large extent for a 25-year period.

Rate of growth in size of farm as measured by the number of unpaid inputs is approximately proportional to the increase in number of acres per farm. Between 1935 and 1955, real estate accounted for slightly more than 55 percent of all nonpaid inputs. The growth in size of the average family-operated farm is relatively small from year to year. But over the years the increase is significant.

The average family operated a 38-percent larger farm in 1955 than in 1935. This growth was

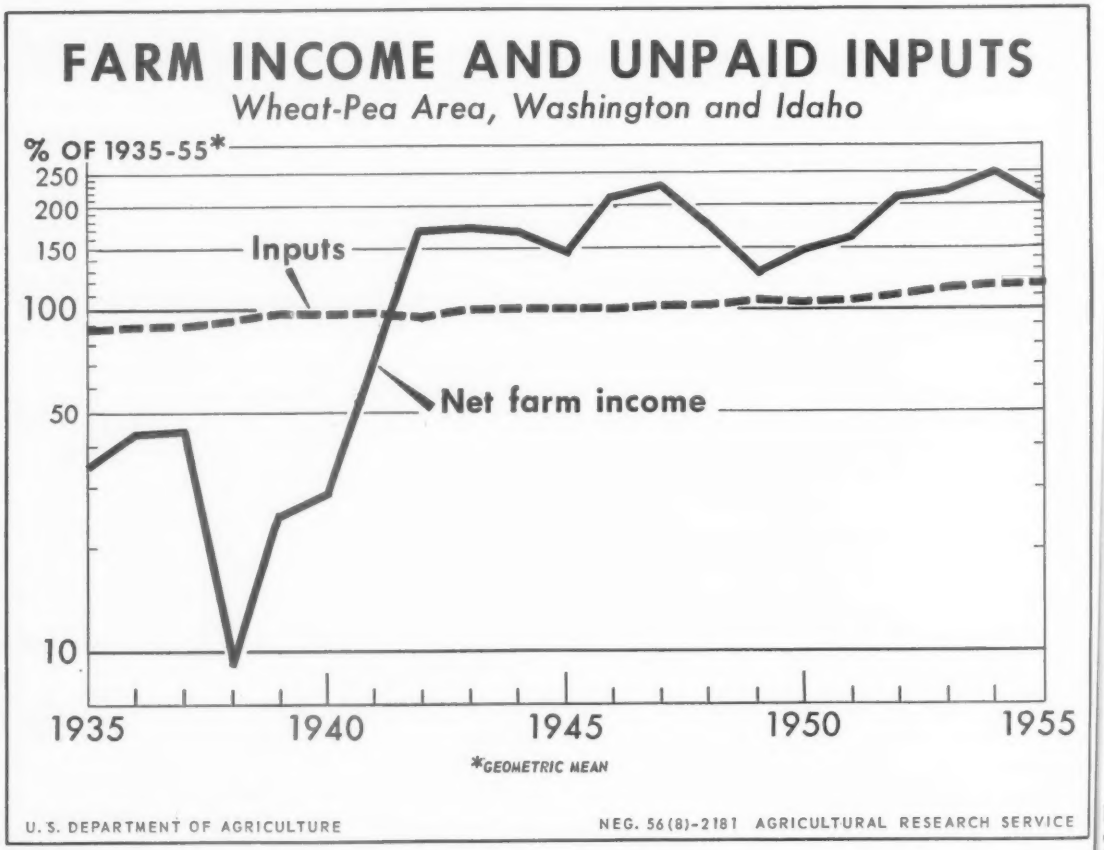

FIGURE 1.

TABLE 3.—*Real estate and its income, wheat-pea area of Washington and Idaho, 1935–55*

Year	Area per farm	Value per acre	Total value per farm	Interest rate	Returns per acre based on—			Total farm returns based on—		
					Interest	Share rent	Imputed rate	Interest	Share rent	Imputed rate
	Acres	*Dollars*	*Dollars*	*Percent*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1935	389	57	22, 173	5. 7	3. 25	2. 69	3. 25	1, 264	1, 048	1, 265
1936	401	57	22, 805	5. 2	2. 96	3. 29	3. 95	1, 186	1, 321	1, 582
1937	397	65	25, 976	5. 1	3. 34	3. 37	3. 61	1, 325	1, 339	1, 432
1938	410	66	27, 126	4. 9	3. 24	1. 78	. 80	1, 329	729	327
1939	421	62	26, 228	4. 8	2. 99	2. 33	2. 13	1, 259	982	898
1940	426	68	29, 057	4. 7	3. 21	2. 68	2. 46	1, 366	1, 141	1. 049
1941	427	68	29, 074	4. 6	3. 13	4. 58	6. 10	1, 337	1, 955	2, 605
1942	426	74	31, 686	4. 6	3. 42	8. 69	14. 34	1, 458	3, 704	6, 107
1943	440	86	37, 946	4. 4	3. 80	9. 10	14. 06	1, 670	4, 006	6, 184
1944	453	101	45, 912	4. 4	4. 46	9. 41	13. 93	2, 020	4, 262	6, 309
1945	444	115	51, 162	4. 6	5. 30	8. 69	12. 02	2, 353	3, 857	5, 336
1946	457	135	61, 530	4. 7	6. 33	11. 19	17. 45	2, 892	5, 114	7, 976
1947	476	159	75, 544	4. 6	7. 30	12. 16	18. 21	3, 475	5, 788	8, 668
1948	474	180	85, 202	4. 6	8. 27	9. 68	14. 00	3, 919	4, 586	6, 636
1949	494	186	91, 738	4. 6	8. 54	7. 27	9. 68	4, 220	3, 593	4, 784
1950	482	186	89, 759	4. 6	8. 57	8. 57	11. 48	4, 129	4, 129	5, 533
1951	498	214	106, 576	4. 6	9. 84	9. 68	12. 21	4, 902	4, 820	6, 092
1952	507	224	113, 568	4. 6	10. 30	12. 51	16. 03	5, 224	6, 343	8, 129
1953	512	216	110, 592	4. 6	9. 94	12. 04	15. 87	5, 087	6, 163	8, 124
1954	524	221	115, 848	4. 6	10. 17	12. 44	17. 48	5, 329	7, 073	9, 161
1955[1]	536	227	121, 763	4. 8	10. 90	9. 27	10. 74	5, 845	4, 970	5, 756

[1] Preliminary

made possible chiefly by an increase in working capital. In 1935, working capital accounted for 477 unpaid inputs, or 9 percent of the total. In 1955, it accounted for 1,193 inputs, or 15 percent of the total.

As the size of farm has increased with additional acres and more working capital, family labor has of necessity supplied proportionately less of the total inputs. In 1935, family labor supplied 4 times as many inputs as working capital, whereas in 1955 it supplied only twice as many.

Return to Real Estate

The return to real estate has been estimated on three different bases: (1) Estiamted total value of real estate times the current interest rate on farm mortgages; (2) customary share rent; and (3) imputed rate (table 3).

Estimated values of real estate as used here are based on average prices paid for land in the area. These sales reflect the judgment of landlords and farmers as to what they think their land is worth. In making their appraisals, consideration is given to current and prospective income. About 3 percent of the farmland changes ownership each year as a result of voluntary sale. The owners of the other 97 percent probably consider that, to them, farmland is worth more than the going market price.

For most of the years 1938 through 1955, it is clear that the current market price of land was undervalued relative to the succeeding year's price. This was particularly true from 1942 through 1948 when the market price each year was from 13 to 17 percent higher than in the previous year. Economic instability, characterized by the period 1935–55, makes it difficult to determine what land is actually worth. It is obvious that the market price of farmland cannot reflect accurately the year-to-year changes in net farm income.

Interest rates on farm mortgages in the area declined from 5.7 percent in 1935 to 4.4 percent in 1943. Thereafter, they remained at about 4.6 percent until 1955, when they averaged about 4.8 percent. There appears to be little relationship in the short run between the interest rate on mortgages and the income from land.

Share rent probably comes closer to reflecting the annual contribution of land to net income than the estimated market value of real estate times the mortgage interest rate.

The share rent shown in table 3 is the value of the landlord's share of the crops at market price less his expenditures for buildings, fences, and real estate taxes. The landlord usually received a third of the grain and a fourth of the hay and peas. The return to land based on share rent fluctuates more from year to year than does the return to land based on interest because crop yields and prices of farm products are highly variable.

These fluctuations tend to be in the same direction as fluctuations in net income. But we have some empirical evidence to indicate that the fluctuations in share rent given in table 3 do not show the full variation in the contribution of land to net income. In years of low net income, net share rent is probably higher than the contribution of land to earnings; in years of high net income, it probably is less than the contribution of land. From area to area, share rents tend to increase as the productivity of land increases. In a given area, share rent is established as a normal or general average and remain inflexible from year to year.

Beginning with 1941, incomes in the Palouse area have been relatively good. This is reflected in the increasing *value* of share rents and also in returns based on interest charges. These increases, however, probably do not fully reflect the increased contribution of land to net income since 1941. There have been some reports of increases in the share paid as rent.

The current difficulties of farmers in acquiring additional land to rent support the belief that the share paid as rent is increasing. But the rental market for land is far from perfect in an economic sense. Many farmers have rented at least parts of their farms for a generation.

So long as the returns to the landlord increase and prospective land values and prices of farm products improve, landlords are usually satisfied with existing rental terms. In these circumstances, tenants also are reasonably satisfied with their leases. Consequently, relatively few farms are available for leasing to new tenants. Of late years, tenants who have wanted to stop farming have been able to dissolve their leases and sell their farm equipment on favorable terms.

In general, the imputed rate of return to land is above or below the rate determined by share rent, depending on whether the rate based on share rent is above or below that determined on the basis of the market value times the interest rate.

Return to Working Capital

The return to working capital was estimated on two different bases: (1) The estimated value of working capital times the going rate of interest, and (2) the imputed basis (table 4).

The quantity of working capital was valued each year on two different bases: (1) At current prices and (2) at 1947–49 prices. Multiplying the valuation based on current annual prices by the interest rate on short-time loans gives the annual returns based on interest.

Dividing the imputed return to working capital by the actual value of the capital gives the imputed rate on the actual value. For the year 1935, the imputed return was $193; the actual value of the capital was $3,934; and the imputed rate on the actual value was 4.9 percent.

For the years 1935 through 1940, the imputed rate was substantially less than the interest rate. In view of the fact that capital increased rapidly during this period, the productivity of capital may have been considerably greater than was indicated on the basis of relative costs at 1947–49 rates. Part of this was due to the change in relative costs from the decade of the 1930's to the decade of the 1940's. From 1935–39 to 1947–49, wage rates for hired labor rose more than twice as much as costs of capital. If the 1935–39 period had been used to establish the rates of factor inputs, a considerably larger sum would have been allocated to capital.

After 1940, interest rates declined and net farm income increased. In general, if capital earns much more than the interest charges, farmers tend to buy more capital items. In accordance with this tendency, the number of items of machinery and power bought by farmers in the 1940's increased greatly. The rate of purchase was held down by farmers' inability to obtain all the machinery they wanted because of wartime restrictions, or by their inability to expand their farm acreages. The greatest dispersion between the interest rate and the imputed rate was in 1946. Since 1946 the margin between the two rates has narrowed.

TABLE 4.—*Working capital and its earnings, wheat-pea area of Washington and Idaho 1935–55*

Year	Valuation of working capital		Rate of return on actual value		Annual return	
	1947–49 valuation	Actual value	Interest rate	Imputed rate	Based on interest	Imputed
	Dollars	*Dollars*	*Percent*	*Percent*	*Dollars*	*Dollars*
1935	9,005	3,934	6.5	4.9	256	193
1936	9,972	4,564	6.4	5.7	292	259
1937	11,703	5,859	6.4	4.7	375	278
1938	13,861	6,554	6.4	1.1	419	73
1939	15,461	6,211	6.5	3.5	404	217
1940	16,065	6,912	6.5	3.8	449	260
1941	17,293	7,442	6.0	9.3	447	695
1942	16,382	8,972	5.8	17.2	520	1,546
1943	19,285	12,732	5.8	14.0	738	1,784
1944	16,818	12,222	5.7	12.6	697	1,541
1945	17,891	13,379	5.4	10.6	722	1,415
1946	18,075	13,668	5.2	15.2	711	2,077
1947	19,282	16,659	5.2	13.9	866	2,312
1948	18,135	20,085	5.2	8.3	1,044	1,671
1949	19,791	20,611	5.3	6.1	1,092	1,262
1950	18,620	17,847	5.4	7.9	964	1,407
1951	19,623	20,742	5.5	7.6	1,141	1,578
1952	19,490	23,001	5.6	8.9	1,288	2,058
1953	21,016	24,398	5.7	9.0	1,391	2,196
1954	21,428	23,871	5.7	10.3	1,361	2,467
1955	22,516	24,746	5.7	6.4	1,411	1,591

Return to Family Labor (Exclusive of Government Payments)

Returns per hour to family labor were estimated by four methods: (1) By valuing family and operator labor at wage rates paid to hired labor without board; (2) by imputation; (3) by assuming a return to the farm operator and family equal to that of a share renter; and (4) by assuming that family labor is a residual claimant after all other charges and allowances are paid (table 5).

The imputed method has been explained and the hired-labor basis is self-explanatory. The return based on share rent starts with net farm income, from which is deducted the value of the net share rent and the value of working capital at current interest rates. The method of determining share rent was explained in the real estate section. The current interest rate is based on short-term or intermediate credit loans. The residual method is the one usually adopted by most farm-management studies. This method deducts from net farm income the interest on working capital and the interest on real estate values at current prices.

The variation in the hired labor rate reflects general price movements. The variation in the rate based on imputation reflects the variation in net farm income. The variation in the rate based on share rent magnifies the variation in net farm income. The variation in the rate based on the residual method magnifies even more the variation in net farm income. In times when incomes are unfavorable, the rates are in this order starting from the lowest: (1) Residual; (2) share rent; (3) imputed; and (4) hired labor (fig. 2). In good times, this order is reversed.

Summary and Conclusion

The method by which net farm income is allocated to the unpaid factors of production should depend upon (1) the purpose for which the allocation is designed and (2) the effectiveness with which the method accomplishes this purpose. This paper presents an imputation method of allocating net farm income as an alternative to the more usual market-price method.

The market-price method assumes that each factor earns a return equal to the price it could

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demand in the market. This method was used in showing the returns to labor at wage rates for hired hands, returns to working capital at market value times short-time interest rates, and returns to real estate at market value times interest rates on longtime mortgages. The market-price method allocates all net farm income to the unpaid factors of production only when prices equate their marginal productivities.

In most years since 1935, the sum of the returns to operators of wheat-pea farms in Washington and Idaho based on market prices has not equaled net farm income. For some years, the difference between net farm income and the sum of the value of all inputs at market prices is greater than net income itself.

The failure of market prices to equate net farm income is frequently resolved by using market prices for two of the factors, usually land and working capital, and allowing the residual to go to the other factor, usually labor. This is the so-called labor-income method. It was illustrated as the residual method for (1) the owner operator and (2) the share renter.

The residual method for the owner operator would be analogous to a tenant paying cash rent for all his capital on the basis of its value times the current rate of interest on farm mortgages. Few if any farmers are in this category, as landlords do not operate on this basis. The residual method may be a useful tool to an owner operator in learning whether he would be financially better off had he sold out, invested his capital at the going interest rate, and worked at some other occupation. An individual farmer can always sell his farm at the market price. However, this is not true of all farmers in the aggregate. For this reason, the residual method is not suitable for aggregative analysis.

In a period of disequilibrium the distortion in market prices is amplified in returns to family labor when these returns are computed by the residual method. For this reason, the residual method is poorly adapted to evaluation of the contribution of the unpaid factors to net income. This is particularly true in a time series for all farms in a given area.

TABLE 5.—*Estimated income to family labor exclusive of government payments, wheat-pea area of Washington and Idaho, 1935–55*

Year	Family labor	Income per hour estimated by various methods				Annual income estimated by various methods			
		Hired	Imputed	Share rent	Residual	Hired	Imputed	Share rent	Residual
	Hours	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1935	2156	0. 221	0. 386	0. 456	0. 356	476	833	984	768
1936	2151	. 271	. 469	. 575	. 638	583	1, 008	1, 237	1, 372
1937	2117	. 285	. 428	. 427	. 434	603	907	904	918
1938	2121	. 278	. 094	−. 259	−. 542	590	200	−550	−1, 150
1939	2094	. 274	. 253	. 123	−. 010	574	530	257	−20
1940	2090	. 292	. 292	. 157	. 049	610	611	328	103
1941	2063	. 347	. 725	1. 161	1. 459	716	1, 495	2, 395	3, 010
1942	2051	. 499	1. 703	3. 374	4. 470	1, 023	3, 492	6, 921	9, 167
1943	2041	. 728	1. 669	3. 250	4. 394	1, 486	3, 407	6, 633	8, 969
1944	2002	. 819	1. 653	3. 098	4. 218	1, 640	3, 311	6, 203	8, 445
1945	2002	. 853	1. 428	2. 513	3. 265	1, 708	2, 858	5, 032	6, 536
1946	1956	. 878	2. 073	4. 236	5. 340	1, 717	4, 054	8, 285	10, 446
1947	1977	. 911	2. 162	4. 352	5. 445	1, 801	4, 275	8, 603	10, 765
1948	1995	1. 080	1. 662	3. 005	3. 253	2, 155	3, 316	5, 994	6, 490
1949	1987	. 876	1. 150	1. 834	1. 473	1, 741	2, 285	3, 645	2, 926
1950	2002	. 875	1. 363	2. 287	2. 197	1, 752	2, 729	4, 578	4, 399
1951	1981	1. 096	1. 450	2. 309	2. 160	2, 171	2, 873	4, 575	4, 279
1952	2016	1. 269	1. 904	3. 172	3. 625	2, 558	3, 838	6, 394	7, 309
1953	2230	1. 265	1. 884	3. 124	3. 606	2, 821	4, 202	6, 966	8, 042
1954	2300	1. 252	2. 077	3. 496	4. 224	2, 880	4, 776	8, 040	9, 716
1955 [1]	2300	1. 290	1. 275	1. 726	1. 315	2, 967	2, 933	3, 969	3, 025

[1] Preliminary.

FIGURE 2.

Like the residual method, the imputed method allocates all the income. It assumes that each unpaid factor of production shares in the net farm income in proportion to the amount each would earn at market prices during a normal period. This assumes that the farm is in equilibrium from the standpoint of relative prices for the factors and their productivities, and that the value of these factors in any year would be this cost plus a pro rata share of the profits. Yearly incomes to these resources on these assumptions would be in the nature of rent and hence income should be allocated on the basis of normal shares.

The imputation method gives a more exact approximation of the level of income, at least during the last 10 to 15 years, when relative prices of resource services approximated their 1947–49 relationship.

The method, however, fails to explain fully why the proportions among the resources change. For example, in terms of the 1947–49 price level, wheat-pea farmers had about 2.4 times as much working capital in 1954 per hour of family labor as they had in 1935. This suggests that the relative marginal productivity of labor and capital in the two periods may not have been the same. As a consequence, the imputation method may not correctly allocate the net farm income.

Neither of these methods measures precisely the contribution of each of the unpaid factors to net farm income. This analysis indicates that the imputed method has some advantages over the more conventional methods. The imputed method requires careful selection of base rates for good results. These rates should be revised as economic and technical conditions change.

Objective Forecasts of Cotton Yield

By Walter A. Hendricks and Harold F. Huddleston

An earlier paper [1] on this subject summarized results of studies on the 1954 crop in 10 Southern States. At that time three approaches to forecasting yield from plant observations were considered: (1) the multiple regression approach, (2) a "probability of survival" model, and and (3) an empirical approach. This paper describes a forecasting procedure which developed from these earlier studies as more data became available and as an appropriate way of making use of the fruiting habits of the cotton plant in a forecasting formula was better understood. The most noteworthy advance was the discovery of a simple device for estimating fruiting rate from a maturity classification of plants on August 1. This is of major importance for the August forecast because all of the fruit contributing to final yield is not yet formed by that date. After September 1, additional fruiting is no longer an important factor for the Southern region as a whole. This new approach is being used experimentally in 1956.

Another paper in this issue by Jack Fleischer reports on additional work being conducted on the "probability of survival" model.

COUNTS OF COTTON FRUIT during 1954 and 1955, and the corresponding yields derived from data on ginnings, provide the basis for the yield forecasting procedure described in this paper. That procedure makes use of known fruiting characteristics of the cotton plant and permits plant observations collected during the growing season to be translated into indications of final yield in logical fashion.

Data collected in 1954 and 1955 show that, for all practical purposes, a combined count of blooms, small bolls, large bolls, and open bolls as of September 1 represents the total yield potential for the season. Multiplying that count for small sampling units in sample fields by the weight of seed cotton per boll (as estimated from open cotton picked in the sample fields), noting that 37 percent of the seed cotton is lint, and multiplying by the appropriate expansion factor to convert the result to a pounds-per-acre level, gives that potential in terms of pounds of lint per acre.

The only unknown in the forecast as of September 1, or on succeeding dates, is the fraction of that potential that will go to the gin. Some fruit will fail to mature and some open cotton is missed in harvesting. In 1954, 9 percent of the September 1 potential was lost. In 1955 the loss was 9 percent. In both years almost exactly half of the loss was in the form of fruit that failed to mature; the other half was open cotton found in the fields after harvest which either was missed in picking or had opened after the farmer harvested the crop. Although 1954 was a dry season and 1955 was wet, growing conditions were not sufficiently adverse in either year to cause any unusual damage.

It appears that a loss of about 10 percent of the blooms and bolls present on September 1 can be regarded as a "normal" situation. Applying that deduction to the yield potential represented by the September 1 bloom and boll count and the observed weight of cotton per boll should provide a good forecast of yield as of that date.

For an August 1 forecast the situation is not so simple because a fruit count alone on that date does not tell the whole story. Plants do not yet have their full set of fruit and it is necessary to forecast the number of blooms and bolls still to be formed. Analysis of the 1954 and 1955 data indicates that the additional blooms and bolls that will appear between August 1 and September 1 can be forecast from observations on the stage of maturity of the plants as of August 1. From the maturity classification, it is possible to compute the rate at which plants are fruiting; that fruiting rate can be translated into a forecast of the blooms and bolls that will be added between August 1 and September 1.

On August 1 the weight of cotton per boll must also be predicted because little cotton is open by that date in most of the region. But, it appears likely that mature boll size is related to the fruiting potential already indicated by the August 1

[1] HENDRICKS, WALTER A., AND HUDDLESTON, HAROLD F. A FOUNDATION FOR OBJECTIVE FORECASTS OF COTTON YIELDS. Agricultural Economics Research. 7:108–111. 1955.

plant observations. In 1954 the season was dry and the fruiting potential indicated by the August 1 plant observations was considerably lower than in 1955 when rainfall was more plentiful. The weight of seed cotton per boll was also lower. It appears logical that weather factors that are favorable for fruiting will also give rise to larger bolls, so that a positive correlation should exist between fruiting potential and boll size.

Forecasting procedures based on these observed relationships are being tested on the 1956 crop month by month as the season progresses. The procedures followed and the data on which they are based are described in the following sections.

The August 1 Forecast

The August 1 fruit counts in 200 sample fields for 1954, and in 400 sample fields for 1955, are shown in table 1.

TABLE 1.—*August 1 fruit counts per 10 feet of row*

Kind of fruit	1954	1955
	Number	*Number*
Squares	78. 5	84. 9
Blooms and small bolls	28. 7	23. 5
Large bolls	22. 6	20. 4
Total	129. 8	128. 8

In these counts a boll less than 1 inch in diameter was called a small boll. All other bolls, including those that had already opened, were called large bolls. The bloom count was combined with the small-boll count for purposes of analysis because a bloom lasts only a few days before becoming a small boll.

Although the total fruit count was almost identical in the 2 years, more fruit was in the early stages of development in 1955 because the crop got off to a later start that year. This must be taken into consideration along with the total fruit count in arriving at an explanation of the differences in final yields for the 2 years. The maturity factor can be introduced into the picture most conveniently by classifying all sample fields into three categories according to the kind of fruit found on the plants in the sample-row segments. That classification is shown in table 2.

TABLE 2.—*Classification of fields by maturity of plants on August 1*

Kind of fruit present	Fields	
	1954	1955
	Percent	*Percent*
Squares only	6. 5	24. 9
Squares, blooms, and small bolls	18. 4	21. 3
Large bolls	75. 1	53. 8
Total	100. 0	100. 0

Table 2 shows that in 1954 75.1 percent of the fields had reached the large-boll stage on August 1, but in 1955 only 53.8 percent were in that category. This is significant because the cotton plant has about the maximum fruit load it can carry by the time some of its fruit reaches the large-boll stage. If the total quantity of fruit in all categories on the cotton plant on any date is plotted against time, the resulting chart follows a sigmoid growth curve.

Fruiting increases rapidly during the first 3 weeks after squares begin to appear. About 3 weeks after the first squares are formed, blooms and small bolls begin to appear and the plant is adding fruit at its maximum rate. From that time on, the rate at which fruit is added begins to diminish and continues to decline for the next 3 weeks until large bolls begin to appear. When that stage is reached, the total quantity of fruit on the plant shows little or no further increase. As large bolls begin to appear about 6 weeks after squaring starts, the growth curve may be divided into clearly recognizable portions which can be related to the observable stage of maturity of the plants.

If the maximum fruit load is represented by A, that maximum is reached about 6 weeks after squaring begins. Because the growth curve is approximately symmetrical, the plant has around half its maximum load about 3 weeks after squaring starts; this is the stage at which blooms and small bolls begin to appear.

All plants in the first category of table 2 must be in a stage of maturity corresponding to a fruit load ranging anywhere from zero to A/2, depending upon whether squares are just beginning to appear or whether the plants already have squares

that are almost ready to burst into bloom. The average plant in that category should have been squaring for about 1.5 weeks and should have about a fourth of its ultimate maximum load.

By the same token, plants that show squares, blooms, and small bolls, but no large bolls, should range from those on which blooms are just beginning to appear to those on which some small bolls are almost ready to graduate to the large-boll category. These plants will have been fruiting for 3 weeks to 6 weeks, with an average of 4.5 weeks. The fruit load on an average plant in that category should be halfway between A/2 and A or 3A/4. The average plant in the second category in table 2 thus has about three-fourths of its total final load.

These characteristics of the cotton plant make it possible on August 1 to predict the total quantity of fruit that will be on the average plant by the time it has its total final load. In terms of A, the quantity of fruit on the average plant as of August 1, 1954 is $0.065(A/4)+0.184(3A/4)+0.751(A)=0.905A$. This means that the average plant on August 1, 1954 was carrying 90.5 percent of its total potential load.

Reference to table 1 shows that the total quantity of fruit in all categories on the average plant as of August 1, 1954 was about 130 units. This figure, of course, is in terms of fruit per 10 feet of row. It is clear from what has been said that $0.905A=130$ or $A=144$. This means that the total potential fruit load, as predicted from the August 1 data, is 144 units of fruit.

Similar computations may be made for the August 1, 1955 data. In terms of the maximum potential fruit load, the quantity of fruit already present on August 1 is $0.249(A/4)+0.213(3A/4)+0.538A=0.760A$. This means that on August 1, 1955 the average plant was carrying only 76 percent of its total potential load as compared with 90.5 percent in 1954.

Table 1 shows that on August 1, 1955 the average plant was carrying about 129 units of fruit, expressed in terms of 10 feet of row. The estimated total load is given by $0.760A=129$ or $A=170$. This shows quite clearly that on August 1, 1955 the average cotton plant already showed a much higher fruiting potential than was the case on August 1, 1954—170 as compared with 144.

But the main forecasting problem on August 1 refers to estimating the rate at which bolls are being formed on that date. An approximation to that rate can be derived by noting that the total quantity of fruit on the average plant increases from zero to A in about 6 weeks. The increase during the first 3 weeks is about the same as during the last 3 weeks. The average weekly rate of fruiting during the entire 6-week period is thus approximately A/6.

The 1954 data indicate that on August 1 the rate of fruiting on the average plant was approximately $0.065(A/6)+0.184(A/6)+0.751(0)=0.0415A=0.0415(144)$ or 6 units per week. On August 1, 1955, the corresponding average rate was $0.249(A/6)+0.213(A/6)+0.538(0)=0.0770A=0.0770(170)$ or 13.1 units of fruit per week. This means that on August 1, 1955 fruit was being added to the average plant at a rate 13.1/6.0 or 2.18 times as fast as on August 1, 1954. Table 3 shows that in 1954 17.4 bolls were added to 10 feet of row between August 1 and September 1. Therefore, in 1955 the increase should have been (2.18) (17.4) or 37.9 bolls. The increase which actually took place was 39.3 bolls.

TABLE 3.—*Bloom and boll counts per 10 feet of row as of August 1 and September 1*

Kind of Fruit	1954		1955	
	Aug. 1	Sept. 1	Aug. 1	Sept. 1
	Number	*Number*	*Number*	*Number*
Blooms and small bolls	28.7	12.1	23.5	24.7
Large bolls	22.6	56.6	20.4	58.5
Total	51.3	68.7	43.9	83.2
Change from Aug. 1 to Sept. 1	+17.4		+39.3	

In these computations, bloom counts were combined with boll counts so that a bloom was counted as a boll. Apparently, data available as of August 1 can be used to forecast the number of bolls that will be found on September 1 when rate of fruiting is brought into the picture to supplement the August 1 fruit count. Rate of fruiting can be predicted from data reflecting the stage of maturity of the crop.

To make a forecast of the 1956 crop on August 1, it was convenient to compute a conversion factor for translating the weekly fruiting rate derived from the maturity classification into a forecast of the blooms and bolls to be formed between August

1 and September 1. Plotting the data for 1954 and 1955 on a chart indicated an almost perfect proportional relationship between the two variables. The slope of the proportional line is 2.97. In other words, the number of blooms and bolls still to be formed after August 1 is about 2.97 times the weekly fruiting rate computed from the maturity classification.

The August 1, 1956 fruit counts were as follows:

	Aug. 1 count per 10 ft. of row
Squares	85.5
Blooms and small bolls	29.1
Large bolls	21.3
Total	135.9

The classification of fields according to August 1 maturity stage was:

	Percent of fields
Squares only	8.1
Blooms and small bolls	31.0
Large bolls	60.9
Total	100.0

The estimated percent of a full load carried by the average plant on August 1 was $(0.081)(25)+(0.310)(75)+(0.609)(100)=86.2$. The estimated total potential fruit load was $135.9/0.862=158$. Assuming, as before, that 39.1 percent of the plants had a weekly fruiting rate of $\frac{1}{6}$ of that quantity and that 60.9 percent were no longer adding fruit, the weekly fruiting rate of the average plant on August 1, 1956 was $\frac{(0.391)(158)}{6}=10.3$. The number of blooms and bolls to be formed between August 1 and September 1 was forecast at $(2.97)(10.3)=30.6$. The total number of blooms and bolls one would expect to find on an average 10 feet of row as of September 1, 1956 would then be $29.1+21.3+30.6=81.0$; past experience indicates that about 90 percent of those will represent ginned cotton.

The quantity of cotton per boll must also be predicted for the August forecast because no actual weights are available until a month later. In 1954 and 1955 the average weight of seed cotton per boll was as follows, in relation to the fruiting potential per 10 feet of row computed from the August 1 data:

	Max. fruit load, number	*Seed cotton per boll, grams*
1954	144	4.62
1955	170	5.03

As the maximum fruit load in 1956 was computed to be 158 units, the average weight of seed cotton per boll should be about 4.84 grams. Applying that weight to the 81.0 bolls per 10 feet of row and multiplying by the appropriate expansion factor gives a forecast of 426 pounds of lint per acre. Assuming a normal loss of 10 percent, the yield forecast in terms of cotton to be ginned is 383 pounds per acre.

These computations seem reasonable enough. But some inaccuracy is introduced into forecast of fruit to be formed between August 1 and September 1 by an implicit assumption that plants in an early stage of fruiting by August 1 and plants already more mature will have the same total fruit load in any one season. In dealing with a region as large as this, fields in an advanced stage of maturity on August 1 may be found where yields tend to differ decidedly from those less mature. In other words, there is a spatial correlation between stage of maturity and yielding ability.

Such a disturbing association was found even within Texas. Cotton in the State is generally much farther along by August 1 in lower areas than in the High Plains. Yields in the two areas also tend to differ. Pooling all data for the State, and performing the same computations as shown above, leads to an average yield forecast of 222 pounds of lint per acre. Separate computations for lower Texas and for the High Plains give separate forecasts of 211 and 288 pounds per acre. As about half the cotton acreage in the State lies in each of the two areas, the average for the State computed on a stratified basis is 250 pounds per acre as compared with 222 on the other basis.

Because of such differences, yield forecasts were computed separately for each State in the 10-State region. The average of the State estimates was 357 pounds per acre for the region, which agrees extremely well with the August 1 forecast made by the Crop Reporting Board. It also differs appreciably from the forecast of 383 pounds per acre computed from the pooled data for the region as a whole. This is convincing evidence of need for stratification, at least by States. In a State in which conditions are like those in Texas, within-State stratification is also desirable.

The September 1 and October 1 Forecasts

As pointed out earlier, the blooms and bolls already on the plants by September 1 appear to

determine the yield. It is necessary only to apply the observed weight of cotton per boll to the combined bloom and boll count and to make necessary deductions for losses that will occur between the forecast date and harvest time. Under "normal" conditions the loss appears to be about 10 percent. That figure can be determined more precisely as experience is gained. At present, we have no data to appraise losses that could occur in a year when weevils, disease, or unusually destructive weather factors are serious. Under such conditions losses would be heavier. But until growing seasons of that kind are actually encountered, and experience is gained as to the effects of adverse conditions, there is no basis for an objective computation.

September 1 weights of seed cotton per boll appear to give reliable indications of the average weight for the season. As part of the sampling program, open cotton in the selected sampling units was picked to ascertain the weight of seed cotton per boll in 1954 and 1955. This was weighed in the field and a small quantity taken to the office and reweighed after being air dried. In 1954 cotton was weighed only at the time of the September 1 visit and on the post-harvest survey. The September 1 weight of seed cotton per boll on an air-dry basis was approximately 4.6 grams. The weight on the post-harvest survey was much lower, but has no particular bearing on yield forecasts and estimates. In 1955 all open cotton found in the sampling units was picked and weighed on every visit to the sample fields. Table 4 shows the cumulative average weight of seed cotton per boll for the entire period covered by the observations, except the post-harvest survey.

All open cotton weighed at the time of the August 1 visit was found in South Texas only. In that area the average size of boll was considerably smaller than that of the 10-State region as a whole. By September 1 open cotton was found in a greater part of the region and weights on that date, when combined with August 1 weights, yielded an average which differs only slightly from the final cumulative average for all cotton picked during the season. It appears that the September 1 cumulative average is adequate for yield forecasting purposes. But in view of the fact that bolls opening early in the season may be of different size than those opening later, such differences must be taken into account in years when boll size is related to the date of maturity.

TABLE 4.—*Cumulative average weight of seed cotton per boll in 1955*

Month	Field weight	Dry weight
	Grams	*Grams*
Aug. 1	4. 692	4. 068
Sept. 1	5. 607	5. 024
Oct. 1	5. 594	5. 027

October 1 fruit counts were made for the first time in 1955. On that date 4.2 blooms and small bolls and 75.3 large bolls were found per 10 feet of row. The combined count of 79.5 is lower than the 83.2 present on September 1. Burrs were counted as bolls. The quantity of cotton already picked by August 1 is negligible for the region as a whole and presents no difficulties. By September 1 an appreciable quantity has been harvested, but almost all of that is in South Texas and represents a complete picking of individual fields then being diverted to other uses.

When no observations could be made in such fields, the August 1 bloom and boll count was accepted as the boll count that would have been found at harvest. But by October 1 many fields in various parts of the region have been partially picked, leaving additional bolls to be picked as they mature. There is reason to believe that counts in some of these fields were too low, particularly where cotton was snapped by hand, because burrs are not left on the plants. Then, too, bolls may have been knocked from plants if mechanical pickers were used.

Although the discrepancy is not alarmingly large and some mortality can be expected in a month's time, there is reason to suspect that this count may be too low—particularly for the large bolls. Field observations on cotton are complicated by farm harvesting practices during the season; cotton is being harvested somewhere in the 10-State region during almost the entire period covered by observations on the sample fields. The procedure followed in making fruit counts under this project attempted to arrive at counts each month so as to include bolls that had been picked. In other words, counts were designed to correspond to total final production, not merely to the portion remaining for harvest as of any date.

This difficulty was not encountered in 1954 because no October 1 counts were made in that year.

It may not be serious, but it is a problem that will require additional study. One solution might be to count only bolls still on the plants at the time of each visit to the sample fields and to relate that count to cotton to be picked only after that date. Current ginning data up to that date could be added to the forecast of cotton still to be harvested, as computed from fruit still on the plants, to provide a forecast of the total crop. Such a procedure might not be satisfactory if there is any appreciable lag between the time the cotton is picked and when it is taken to the gin.

If such an approach is impractical, an alternative would be to devise a procedure for getting complete fruit counts on sample plants that are left undisturbed in farm harvesting operations. This would be difficult to put into practice on sample fields when cotton is not picked by hand. Even in fields picked by hand, there is no assurance that farmers would always leave designated sample plants undisturbed, although specifically requested to do so.

A third possibility would be to use fruit counts of plants upon which fruit had been tagged on an earlier visit. Disappearance of tagged fruit would provide an estimate of burrs and bolls lost during harvesting operations. Under this scheme farmers could be instructed to treat tagged plants the same way as those in the rest of the field. But the presence of tags might encourage some farmers to pass up the tagged plants under the impression that they were doing the sampler a favor, even though they had been assured previously that such plants required no special treatment.

Some Growth Factors Affecting the Survival of Cotton Bolls

By Jack Fleischer

As part of the cotton forecasting research reported by Hendricks and Huddleston elsewhere in this issue, intensive studies are conducted in an attempt to make more accurate predictions of the quantity of immature fruit on the plants, as of a given date, which will develop to maturity and contribute to final yield. Those studies are concerned with tracing life histories of individual bolls and trying to find out how various factors affect probabilities of survival of those bolls. Mr. Fleischer, whose institution is cooperating in these studies, here reports on one phase of the problem.

THE PROBLEM of forecasting yield throughout the growing season is essentially a question of forecasting the number of bolls produced, making allowances, when necessary, for fruit still to be formed, and for fruit damaged by weevil, disease, and other causes.

For the August 1 forecast, it is necessary to count the fruit on the plant and to make an allowance for blooms and small bolls still to be added between August 1 and September 1. Apparently this can be done successfully by (1) taking observations on the stage of maturity of the plants, as reflected by the various categories of fruit found to be present on that date, and (2) making use of known relationships between the categories of fruit present and the ultimate total fruit load that the plant is able to carry.

For a forecast as of September 1 or any later date, it is necessary only to count the blooms and bolls already on the plants and to make necessary allowance for the losses that will probably occur between that date and harvest time.

In an effort to learn something about factors that may affect the growth and survival of cotton bolls, which would be useful in making a cotton forecast as of August 1, a detailed study was carried out on a subsample of cotton fields in the Eighth Crop Reporting District of North Carolina in 1955. The procedure consisted of tagging small cotton bolls[1] as of August 1 with different colored tags according to the position of the bolls on the plants.

On about September 1 these bolls (now large), thus identified, were counted again to learn how many still remained on the plants. At the same time other large bolls, not previously tagged, were tagged with different colored tags to identify the age of the bolls. New small bolls on the plants were marked with still other tags. At harvest, bolls from which cotton was picked in each of the categories were counted and relationships were established between the number of bolls harvested and the number of bolls tagged at specified dates during the growing season.

The identifying tags and the bolls to which they apply are listed below:

1. Medium white tag—Small bolls present August 1 which were backed up[2] by one or more other small bolls.
2. Medium red tag—Small bolls present August 1 which were backed up by one or more squares.
3. Medium yellow tag—Small bolls present August 1 which were *not* backed up by either another small boll or square.
4. Large white tag—Open bolls present September 1, not previously tagged.
5. Large yellow tag—Unopen bolls present September 1, not previously tagged.
6. Small white tag—Small bolls present September 1, backed up by one or more other small bolls.
7. Small red tag—Small bolls present September 1, backed up by one or more squares.
8. Small yellow tag—Small bolls present September 1, *not* backed up by either another small boll or square.

Each hill of cotton on which the tagging was done was the first full hill beyond 10 feet of the first row of a randomly selected 10-foot double-row plot. There were 3 such hills per field and 100 fields, giving a sample of 300 hills. Because blank areas in a field never had a chance to come into the sample, no expansions to universe levels were made

[1] Any boll smaller than 1 inch in diameter was considered a small boll.

[2] "Backed up by another boll" is defined as having another boll farther out toward the end of the branch.

from these data. The object of tagging was to find out whether there were significant differences in the behavior of the several categories and to investigate the contribution of each category to final yield.

The Tagging Counts

On August 1 there were 1398 small bolls, including blooms, on the 300 hills of cotton. Of these, 11 percent were backed up by one or more other small bolls (medium white tag), 65 percent were backed up by one or more squares (medium red tag), and 24 percent were not backed up by either another small boll or a square (medium yellow tag). On September 1, 79 percent of the small bolls counted as of August 1 remained on the plants, but the breakdown by categories was 92 percent of those with medium white tags, 83 percent of those with medium red tags, and 62 percent of those with medium yellow tags. Of the small bolls present on August 1 and still on plants September 1, 91 percent were harvested. The relative numbers by categories were 88 percent with white tags, 92 percent with red tags, and 91 percent with yellow medium tags.

TABLE 1.—*Survival of cotton bolls by categories*

Tags	Aug. 1	Sept. 1	Harvest
Medium white	152	140	123
Medium red	905	753	690
Medium yellow	341	210	192
Subtotal	1,398	1,103	1,005
Large white	----	109	106
Large yellow	----	2,361	1,942
Small white	----	8	0
Small red	----	41	5
Small yellow	----	149	21
Subtotal	----	198	26
Grand total	1,398	3,771	3,079

Only 72 percent of the August 1 small bolls were eventually harvested. This group of bolls represented 33 percent of all the bolls that were finally harvested.

Large open bolls present on September 1 which were not previously tagged were almost entirely harvested (106 out of 109). This group represented only 3 percent of the total number of bolls finally harvested.

Because most of the 1955 cotton crop in North Carolina matured between August 1 and September 1, most of the bolls were not yet in the bloom stage by August 1, but were large bolls by September 1. There were 2,361 of these large bolls on the plants by September 1, and 82 percent of them made cotton. This group represented 63 percent of all the bolls eventually harvested.

The final group of bolls tagged on September 1 were small bolls as of that date. Only 13 percent of these eventually made cotton; 12 percent were backed up by one or more squares (small red tag), and 14 percent were not backed up by either another small boll or square. None of the bolls backed up by one or more small bolls (small white tag) made cotton. Only 26 of all the small bolls on September 1 eventually made cotton—less than 1 percent of the total bolls harvested.

Analysis of Results

The three categories of small bolls present August 1 were tested for differences by means of a chi-square test. The criterion used was numbers of tagged bolls that did or did not make cotton. A chi square of 55.607 with 2 degrees of freedom indicates highly significant differences among the three categories. The two categories of small bolls present August 1 that were backed up by (1) one or more other small bolls or (2) one or more squares were tested for differences. A chi-square value of 1.605 with one degree of freedom indicates no significant difference. Small bolls present August 1 might just as well have been placed into only two categories instead of three: (1) Those backed up by one or more other small bolls or one or more squares and (2) those small bolls *not* backed up by either another small boll or square.

A chi-square test for the same three categories of small bolls present *September 1* resulted in a chi square of 1.360 with 2 degrees of freedom. This is not significant; it indicates no detectable differences among the three categories. All small bolls around September 1 could have been put into one category.

Large bolls present September 1 were tested for differences among three categories: (1) Large bolls that were not yet blooms by August 1; (2) large bolls that were small bolls on August 1; and (3) large open bolls that were large unopen bolls on August 1. A chi square of 60.067 with 2 de-

grees of freedom indicates highly significant differences among the three categories. Another test for a possible difference between the latter two categories resulted in a chi square of 4.880 with one degree of freedom. This is significant at about the 3 percent level.

These tests show that the use of three categories would be necessary. Large bolls present August 1 could be marked with tags different from those used on small bolls; those remaining on the plants by September 1 would then be large open bolls. With this category already tagged, only those large bolls present September 1, which were not previously tagged, could be tagged as a separate category.

In summary, five categories appear adequate for classifying bolls according to probability of survival:

(1) Small bolls present August 1, backed up by *either* one or more other small bolls *or* one or more squares.

(2) Small bolls present August 1, *not* backed up by either another small boll or square.

(3) Large bolls present August 1.

(4) Large bolls present September 1, not previously tagged.

(5) All small bolls present September 1.

This experiment was performed during only one growing season and in only one crop reporting district of North Carolina. To evaluate the consistency of these results, information is needed for more years and for different locations.

As mentioned previously, 63 percent of the bolls that made cotton were squares on August 1. Hence any prediction equation developed for an August 1 yield forecast must include a square count in addition to boll counts.

Book Reviews

Marketing—Text, Case and Readings. By Harry L. Hansen. Richard Irwin, Inc., Homewood, Ill. 799 pages. 1956. $8.35

IF ONE IS LOOKING for a "different" text in marketing, this is certainly it. The author disdains the older and more traditional functional, institutional, and commodity alternative types of textbook organization in general marketing. He particularly scorns the pages of description of marketing structures and institutions and the statistical and tabular material which is outdated before the text comes off the press—sometimes even before the author incorporates the material into his manuscript. This book figuratively pulls the student into the executive office and sets him down behind the management desk of marketing firms. It piles problems on top of the desk and compels the student to act in the role of a decision maker for the marketing firm.

The book is organized primarily around certain problem areas about which marketing decisions must be made. These are: (a) product policy, (b) distribution channels, (c) advertising, (d) personal selling, (e) pricing, and (f) sales programs. Each of these chapters follows the same sequence. A text comes first which presents the major problem area and outlines the alternative decisions. Some short problems follow which are built around actual decisions that marketing firms have faced. If the student feels a lack of factual material, the author retorts that business problems do not emerge clothed in the facts and figures necessary for the solutions.

Then comes a series of actual cases of decisions made in industry. These are really more advanced problems. Here factual background is more adequate. For each of the cases, the student is asked to define the problem, determine the alternatives, weigh the risks and gains, and finally come to a judgment about the wisdom of the decision. These are exceedingly, and often entertainingly, well done. Many involve well-known products, firms, and situations. But the obvious question is still the practical one. How did it turn out? This reader would like to see an answer book.

Next come readings which serve to round out the student's background. One of such is Adelman's competent criticism of the position of the Antitrust Division against cost and price reduction in the A & P case. Finally, each chapter ends with a series of 20 to 30 generalizations. The student has the job of sorting the good ones from the bad ones, and finding the degree of truth and error in each.

In this book on problems, the author does dip briefly into the well of theory on infrequent occasions when he feels it appropriate. This book comes from "across the river" at Harvard. The author is a professor in the Graduate School of Business Administration. More frequent theoretical references might have been expected, however, in the 138-page chapter on pricing. The body of legal restraints and regulation on pricing, though, is well presented.

The rationale of price maintenance is given in a fascinating 10-page interoffice memo of a cosmetic firm, which details its almost catastrophic experience with pricecutting and its eventual decision to take refuge behind fair-trade pricing. Another interesting story depicts the dismay of the editor of an advertising trade magazine when he discovered his three advertising executive luncheon guests all had introductory cards to discount houses and used them freely. The editor was the lone "virtuous" soul at the lunch table that day.

This is not an agricultural marketing text. Most professors of agricultural marketing courses, however, will find in it many stimulating supplementary readings. The agricultural marketing researcher will learn much of the setting in which entrepreneurial decisions are made. And this background has become more important to the researcher as expanding marketing research has moved from studies of the first handlers of farm products to the processing, wholesaling, and retailing phases of food distribution.

Gerald Engelman

Fluid Milk Marketing. By George Max Beal and Henry H. Bakken. Mimir Publishers, Inc., Madison, Wisc. 556 pages. 1956. $7.50.

BEAL AND BAKKEN have achieved their objective, "to describe and analyze the entire process of marketing fluid milk in its movement from the farm to the consumer." *Fluid Milk Marketing* is first to do this, and it should find wide use.

The idea of writing such a book has been nursed openly for some years past by a dozen or so teachers and research workers in dairy marketing, some of whom were spurred only by the absence of such a text. Now this incentive is removed. Others had formed their own notions of what such a book would be, and are likely to find reasons yet for not abandoning their intentions.

Description and analysis of the industry from farm production to home delivery constitute parts I and IV of the book. Part I traces the historical development of the dairy industry in the United States and describes the matrix of dairy manufacturing industries in which the fluid milk industry nestles. Part IV describes in detail how the industry is organized for processing and distributing, and the methods by which these operations are carried out.

How prices the dealers pay to producers for milk are established is the concern of parts II and III, following the announced intention of emphasizing the problem of pricing milk. The evolution of pricing methods from about 1860 to the present is traced. The era is divided into three periods typified by the dominant method of pricing in each—"automatic" to about World War I, "administered" to the early 1930's, and "authoritative" thenceforth. Two chapters are devoted to pricing by Government order, one each to State and to Federal programs. Governmental control, in the main, was responsible for formula pricing, and part III covers this aspect of the pricing problem.

The market for a book on dairy marketing may be so limited that an author feels great economic pressure to put within the covers something for everyone. As a result, any given reader will find his interest fluctuating sharply from section to section. Parts I and IV would be suited to undergraduate classes, but much of the material on pricing would prove tedious. Advanced students, research workers, and men in industry who must construct, defend, or rebut pricing proposals will find invaluable the history and analysis of the Boston, New York, and Philadelphia price formulas. At the same time many will feel that pricing on the basis of manufactured dairy products receives too little attention.

Great changes have occurred in the marketing of dairy products within the last decade, even as during the decade before that, and so back through this century. Some of these changes are reflected faithfully in this book—formula pricing, for example. Other changes are reflected less well; bulk milk handling and outer-market distribution appear almost as afterthoughts. And some recent changes are scarcely acknowledged, changes in methods of processing and handling particularly.

The authors rely on a description of receiving operations observed by C. E. Clement in the 1920's for their discussion of internal factors affecting efficiency. That similar conditions were found in Vermont in recent years—a heavy investment in obsolete equipment—shows only that obsolescence is not tantamount to abandonment. The continuous-flow pasteurizing methods described are partly archaic. The continuous-flow flash pasteurizers widely adopted in progressive plants since World War II are scarcely acknowledged. Had the authors made use of current trade publications the descriptions would have been less dated.

The book greatly overstresses some aspects of milk marketing. One example is the disproportionate emphasis on localized jurisdiction over sanitary standards. Some States have made great strides in freeing the movement of milk within their borders, California, for example. The Conference on Interstate Milk Shipments also is helping to build a technical basis for confidence in reciprocity of inspection. Without such confidence, localized programs are supported far more strongly by the potential health hazard than by economic pressures.

One refreshing feature of the book is its relative freedom from provincialism. Although Northeastern or North Central conditions and practices influence some sections of the book, the authors' firsthand knowledge of the Far Western

industry gives an exceptional regional balance. Also outstanding is the exposition of fluid-milk pricing theory. Succinct and clear, it is a marked improvement over the standard sources for the purpose of teaching the principles.

Louis F. Herrmann

The Mathematical Theory of Sampling. By Walter A. Hendricks. The Scarecrow Press, New Brunswick, N. J. 364 pages. 1956. $7.50.

THE FIRST FEATURE to strike the eye on opening this volume is the unusual typography. The entire work was hand lettered for offset reproduction by a practitioner of the ancient art of calligraphy, conjuring visions of a medieval scholar so engrossed in his solitary labor as to be completely isolated from a technological revolution ushered in by one Johannes Gutenberg. This recurrence to the Middle Ages was a practical device hit upon by the publisher to avoid costly methods of setting up a mathematical work in type. It succeeded in its purpose, but the style of lettering and some crowding of words make parts of the text tiring to read.

From the preface we note that: "This work is addressed to students who wish to become familiar with formulas and computations incident to sample design and the analysis of sample data. . . ." The author is well qualified to write on this subject—he has been working in his field for many years and has taught statistical methods in the Graduate School of the United States Department of Agriculture and at other institutions. The book contains 11 chapters. The first 4 deal with basic statistical concepts and theory and the last 7 with the theory and procedure of various sampling techniques.

The chapters on concepts and statistical theory cover random sampling, expected values, covariance, fiducial probability, the distribution of means of samples from normal and nonnormal distributions, and the importance of a careful definition of the universe. The discussion of sampling methods and procedures encompasses stratified sampling, multistage sampling, ratio and regression estimates, measurement of heterogeneity in a universe, definition of sampling units and their selection with equal and unequal probabilities, and nonsampling errors in surveys.

According to the author, ". . . the treatment is aimed at mathematical principles and is intended only for readers who have some mathematical literacy." To understand fully the material presented, some knowledge of elementary statistics also is required. Most of the book can be followed if a reader is reasonably familiar with algebraic procedures and has this elementary knowledge of statistics.

Some calculus is encountered throughout the book. The mathematics in the discussion of the distribution of sample statistics will be too heavy for the student who is not reasonably well prepared in the calculus. But failure to understand the mathematics of this chapter does not prove much of a handicap in understanding the remaining chapters. A fair background of statistics definitely is required because the author uses the methods of elementary statistics to rationalize some of his basic relationships; that approach enables him to employ rather short and nonmathematical developments.

Even less advanced students will find most of the text clear and instructive, although they may at times be confused by the use of the same letters for various purposes. For example:

S denotes a summation;
s denotes a standard deviation;
s denotes the deviation of a stratum mean from the general mean;
K denotes the number of observations in a population or stratum;
K is used as a La Grange multiplier.

But the terms are always clearly defined so the careful student should have no difficulty in following developments. The numerical illustrations are good. They are short and do not require a large amount of computation if the reader wishes to follow the arithmetic in detail. Discussions of examples that deal with agricultural problems are realistic. Practical problems are pointed out and discussed in relation to the theory employed. This is especially important in the discussions of systematic sampling and response errors.

The index is rather short, but each chapter has a comprehensive list of references.

My overall evaluation is that the student with

some knowledge of statistics will find this book a valuable contribution to the literature in the field of sampling. It is strongly recommended to anyone who is faced with the problem of designing sample surveys in the field of agriculture.

Roy A. Chapman

A Basic Bibliography on Marketing Research. Compiled by Hugh G. Wales and Robert Ferber. American Marketing Association. 164 pages. 1956. Member $3, nonmember $5.

THE AMERICAN MARKETING ASSOCIATION has issued this second work in its basic bibliography series; the first was published in 1954 under the title, *Current Sources of Information for Market Research.* This second bibliography provides "references to literature covering a broad range and scope of marketing research activity." Professors Wales and Ferber compiled a selected—not a complete—list of references, with those judged worthy of special attention indicated. In some instances the type of audience most interested in the work is also given. For the most part, literature published before 1939 is excluded.

Although they may risk criticism from their colleagues as to their individual selections, the compilers have achieved their stated purpose of "a relatively short, up-to-date and annotated set of references in the area of marketing research." Brief notes describe the content of each reference. These are helpful and informative and should save researchers much time that would otherwise be spent in unfruitful searches of literature in library stacks.

The bibliography is divided into six major divisions: Background materials, techniques, areas of research, the research report, research administration, and miscellaneous aspects. References listed under "techniques" comprise almost half of the book and those under "areas of research" about a third.

Only a few of the subject-matter references are in the area of agricultural marketing. For agricultural economists engaged in marketing research, the chief value of the bibliography probably will be in the references to techniques. In addition to many references to the literature of sampling and sampling design, the bibliography gives special emphasis to works dealing with interviewing, attitude and opinion measurement, and projective and other psychological methods. These latter subjects are receiving increasing attention in marketing research.

Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Colleges[1]

BARTON, GLEN T., AND ROGERS, ROBERT O. FARM OUTPUT. PAST CHANGES AND PROJECTED NEEDS. U. S. Dept. Agr. Agr. Inform. Bul. 162, 44 pp., illus. August 1956.

The volume of farm output needed in 1975 may be about a third larger than the output in 1951–52. Annual increases required between the two dates may be half again as large as occurred during the long-run period, 1910–12 to 1951–53, and about a fifth greater than the post-World War II annual increase registered from 1944–46 to 1951–53.

BIRD, RONALD. TAXES LEVIED ON FARM PROPERTY IN THE UNITED STATES, AND METHODS OF ESTIMATING THEM. U. S. Dept. Agr. Statis. Bul. 189, 47 pp. August 1956.

This report explains the current method of estimating these taxes and brings together the tax estimates through 1954, going back to 1909 for farm real estate taxes and to 1924 for farm personal property taxes. The first attempt to obtain a national estimate of the property taxes levied on farmers was made in October 1922 by the former Bureau of Agricultural Economics.

BOWLES, GLADYS K. FARM POPULATION—NET MIGRATION FROM THE RURAL-FARM POPULATION, 1940–50. U. S. Dept. Agr. Statis. Bul. 176, 174 pp., illus. June 1956.

A net of 8.6 million persons alive at both the beginning and end of the decade migrated from farms between 1940 and 1950. Net outmigration for 1940–50 was 31 percent, compared with 13 and 19 percent respectively for 1930–40 and 1920–30. In 1940–50, rates for children and for persons 25–44 were low in most areas; rates for those 10–19 in 1940 were highest in all areas. Rates of net outmigration were usually higher for nonwhite persons than for white.

BOWLES, GLADYS K., AND TAEUBER, CONRAD. RURAL-FARM MALES ENTERING AND LEAVING WORKING AGES, 1940–50 AND 1950–60—REPLACEMENT RATIOS AND RATES. U. S. Dept. Commerce and U. S. Dept. Agr. cooperating. Series Census-AMS (P–27), No. 22, 65 pp., illus. August 1956.

The number of men aged 20 to 64 in the rural-farm population in 1950 was about 6 million. If there is no net migration to or from farms of young men entering this working age group during 1950–60 and the number of farm job opportunities remains approximately the same as in 1950, only about 60 percent of the young men reaching working age would find economic opportunity on farms. If, as is probable, the number of farms continues to decline between 1950 and 1960, and mechanization continues to increase, an even higher number must seek employment in nonfarm areas.

[1] Processed reports are indicated as such. All others are printed. Such publications may be obtained from the issuing agencies of the respective States.

BRODELL, ALBERT P., AND KENDALL, ALBERT R. LIQUID PETROLEUM FUEL. CONSUMPTION FOR FARM PURPOSES. U. S. Dept. Agr. Statis. Bul. 188, 25 pp. July 1956.

In 1953, farm consumption of liquid petroleum fuel, including L. P. gas, was estimated at 8.8 billion gallons, or 27 percent more than the 7.1 billion gallons estimated for 1947. About 77 percent of the total used in 1953 was used as motor fuel.

CRECINK, JOHN C. TENANT FARMERS, SOUTH PLATTE VALLEY, COLORADO. HOW THEY GET FARMS AND ACCUMULATE CAPITAL. U. S. Dept. Agr., Agr. Res. Serv. ARS 43–18, 81 pp., illus. August 1956.

Personal farm interviews with 197 tenant operators in the spring of 1951, supplemented by census data and information from farm-record accounts data maintained by the Economics and Sociology Section, Colorado Agricultural Experiment Station, formed the basis for this report. It was found that tenancy rates on irrigated lands are nearly twice as high as on surrounding dry land. Both related and nonrelated tenants received substantial family backing in getting established in farming. Their average beginning net worth in 1950 dollars was $3,078. The livestock enterprise made the chief contribution toward accumulation of capital, followed by opportunity to accumulate, number of years experience as a farm operator, productivity of the farm, and its size.

FRICK, G. E., AND HENRY, W. F. PRODUCTION EFFICIENCY ON NEW ENGLAND DAIRY FARMS V. ADJUSTMENTS IN OBTAINING DAIRY HERD REPLACEMENTS. N. H. Agr. Expt. Sta. Bul. 430, 73 pp., illus. August 1956.

This publication is directed primarily toward developing information on the physical relationships involved in dairying and a method of using information about them in making economic decisions on how best to provide dairy-herd replacements. A dairyman needs to decide how he can best use his roughage, barn space, and labor, and his other production facilities, to achieve maximum income in view of his costs of production, price of purchased replacements, and price of milk. Milk-production rates were about the same for both raised and purchased cows. But New England dairymen would find it economically advantageous to shift from raising to buying replacements within the framework of current prices and technology.

GERHARDT, FISK, SCHOMER, HAROLD, WRIGHT, T. R. SEALED FILM LUG LINERS FOR PACKING BING CHERRIES. U. S. Dept. Agr. AMS–121, 8 pp., illus. September 1956.

Mylar and polyethylene films were used as sealed film box liners for the regular 15-pound standard wooden cherry lug. Mylar film required perforation at both 36° and 65° F. to prevent impairment of flavor. Polyethylene box liners required perforation at 65°. Decay was markedly reduced and stem freshness and fruit brightness were preserved by packaging cherries in sealed polyethylene film box liners.

GILLILAND, C. B., AND SMITH, T. B. AN ANALYSIS OF THE PEANUT SHELLING INDUSTRY, 1950–51 THROUGH 1952–53. U. S. Dept. Agr. Mktg. Res. Rept. 134, 43 pp., illus. August 1956.

Activities of peanut-shelling plants varied little from year to year during the 3 years studied; in number of months of operation and in rate of receipts. Compared with 1950–51, the number reporting operations for 1951–52 was about 2 percent greater and for 1952–53 about 10 percent less. A similar comparison for volume cleaned and shelled shows 1951–52 with about 33 percent less and 1952–53 about 29 percent less. Yield of kernels in shelling is important, and obtaining maximum yield of peanuts for which prices are greater may determine a sheller's profit or loss.

GLASGOW, ROBERT B. FARM FAMILY INCOME: ITS DISTRIBUTION AND RELATION TO NONFARM INCOME. U. S. Dept. Agr., Agr. Res. Serv. ARS 43–34, 44 pp., illus. July 1956.

The median cash income of all farm families and unrelated individuals in the United States during 1949 was $1,564. Median incomes of $1,500 or more were found in 225 State economic areas. Only 20 of these are in the 13 Southern States, and 11 are in Texas. The 135 areas with median incomes of less than $1,500 are heavily concentrated in the South. Comparisons of farm-nonfarm income are made. In many areas, rural farm families make up only a small percentage of nonfarm families.

GROVE, E. W., AND CANNON, M. F. NEW INDEX NUMBERS OF FARM MARKETINGS AND HOME CONSUMPTION. U. S. Dept. Agr., Agr. Handb. 109, 34 pp., illus. July 1956.

Presents a new index of the volume of farm marketings and home consumption. Provides a complete set of subindexes in this new series. Gives detailed weight-period data on prices, quantities, and values underlying the index numbers.

HOCHSTIM, ESTHER S. SELECTED DATA RELATING TO WOMEN'S ATTITUDES TOWARD WOOL AND OTHER FIBERS IN SUITS, SKIRTS, AND SWEATERS AND IN HOME SEWING AND KNITTING. U. S. Dept. Agr. AMS–140, 17 pp. September 1956.

This preliminary report of an extensive study presents a preview of some of the major findings relating to women's use of and attitudes toward wool and other fibers in three items of clothing: fall, winter, and spring suits and skirts, and sweaters. Included are certain tables on moth-proofing, methods of cleaning and washability, sweater purchase, knitting, and home sewing. A full report is being prepared.

HOECKER, R. W., AND KRIESBERG, MARTIN. JOB ATTITUDES OF SUPERMARKET EMPLOYEES. U. S. Dept. Agr. AMS–142, 8 pp. September 1956.

Of the employees interviewed in 28 units of an eastern supermarket organization, 47 percent indicated they were satisfied with their jobs, 37 percent were neither satisfied nor dissatisfied, and 16 percent were dissatisfied. Differences in opinions regarding job satisfaction among employees in different age, sex, job tenure, department of work, and other classifications are given.

HOWELL, L. D. INFLUENCE OF CERTIFICATED STOCKS ON SPOT-FUTURES PRICE RELATIONSHIPS FOR COTTON. U. S. Dept. Agr. Tech. Bul. 1151, 28 pp., illus. October 1956.

Main purpose of this bulletin is to show the relationships between prices of spot cotton and of futures contracts, the relation of the quantity and quality of cotton in certificated stocks to spot-futures price spreads, and the nature and extent of variations in the classifications of cotton included in certificated stocks; and to indicate the influence of these and other factors on spot-futures price relationships for cotton.

HUGHES, WILLIAM F., AND MAGEE, A. C. CHANGES IN INVESTMENT AND IRRIGATION WATER COSTS, TEXAS HIGH PLAINS, 1950–54. Tex. Agr. Expt. Sta. Bul. 828, 8 pp., illus. Mar. 1956. (In cooperation with the U. S. Department of Agriculture.)

This report is based on a farm survey conducted in June 1955 and designed to ascertain changes in investment and operating costs required to keep abreast of the changing situation in water supply. The 1954 average water cost per acre more than doubled the 1947–49 average learned from an earlier study. Additional capital investment on farms making improvements in irrigation facilities averaged $7,600 in the sandy-land area, $5,664 in the heavy land area, and $6,642 for all farms surveyed.

HUNTER, D. L., KAFER, FRANCIS, AND MEYER, C. H. THE EFFECT OF APPLE HANDLING METHODS ON STORAGE SPACE UTILIZATION. U. S. Dept. Agr. Mktg. Res. Rept. 130, 18 pp., illus. July 1956.

Smaller labor costs, smaller crews, and less bruising and damage to fruit are some of the advantages of today's more mechanized methods of handling apples. But a storage plant operator should not decide to change from one handling method to another solely on the basis of the gross revenue. Three sizes of storage rooms were studied—two were typical of many found in older multiple-story plants and one was of modern design.

JAY, J. E., AND ENGER, M. R. RAILROAD TRANSPORTATION OF ROUGH RICE IN LOUISIANA AND TEXAS. U. S. Dept. Agr. Mktg. Res. Rept. 136, 15 pp., illus. September 1956.

Three methods of handling rice were studied—in sacks, bulk handling in boxcars, and bulk handling in covered hoppers. The first method was by far the most expensive in terms of labor costs. Loading and unloading a boxcar of sacked rice cost $30, compared with $7.62 for bulk handling in boxcars, and $5.20 for bulk handling in covered hopper cars. With complete conversion to bulk storage and handling methods, it would be possible to install more efficient loading spouts and receiving pits for covered hopper cars.

JOHNSON, T. D., BLACKMORE, W. E., SIEDSCHLAG, E. W., AND RICHEY, P. S. GRAIN MARKETING FACILITIES AND PRACTICES IN SOUTH CAROLINA. U. S. Dept. Agr. Mktg. Res. Rept. 138, 41 pp., illus. October 1956.

Additional good storage space is needed on farms in South Carolina for about 36 million bushels of grains remaining on farms 1 month or longer and in off-farm fa-

cilities to replace about half a million bushels of poor storage space. Major improvements are needed in off-farm facilities in 12 counties and minor improvements in 20 counties. In 13 counties, the quantity of grain moving from farms or the location of good elevators in adjacent counties would make new grain-handling facilities financially hazardous.

KRIESBERG, MARTIN, AND LEIMAN, MARTIN. IMPROVING THE EFFECTIVENESS OF SUPERMARKET MANAGERS. U. S. Dept. Agr. Mktg. Res. Rept. 125, 45 pp., illus.

In stores tested in the experiment, the new practices resulted in improved employee relations and better work methods. These improvements led to more effort going into store merchandising and increased sales per man-hour. Conformance to company directives in the test stores increased from 50 percent before to 79 percent after the new practices were introduced.

MORTENSON, W. P. TRENDS IN THE POULTRY INDUSTRY . . . EFFECTS ON THE MIDWEST. North Central Regional Pub. 73, 88 pp., illus. (Wis. Agr. Expt. Sta. Bul. 523.) (Agr. Expt. Stas. of Ill., Ind., Iowa, Kans., Ky., Mich., Minn, Mo., Nebr., N. Dak., Ohio, S. Dak., Wis., and U. S. Dept. Agr. cooperating.) June 1956.

Striking trends have taken place in the poultry industry during 25 years. Purpose of this bulletin is (1) to describe the trends, (2) to point out the principal contributing reasons, and (3) to present ideas as to what trends we may expect in future.

NADEN, K. D., AND JACKSON, G. A., JR. FINANCING WESTERN BROILER PRODUCTION. Calif. Agr. Expt. Sta. Bul. 753, 32 pp., illus. May 1956.

Examines sources of financing used by producers in Washington, Oregon, Utah, and California; analyses credit plans; and shows effects of the plans on industry development. Data collected from 44 major financing agencies concerned (1) relation of the agency to the broiler industry, (2) cost of credit, (3) conditions and practices for financing products, and (4) amount of credit used.

POATS, F. J., AND PARKER, R. W. MARKETING MOLASSES FOR LIVESTOCK FEED. U. S. Dept. Agr. Mktg. Res. Rept. 132, 23 pp., illus. Sept. 1956.

Relatively satisfactory prices for molasses in comparison to other feeds has encouraged feeders to mix molasses with such low-value feeds as corncobs, straw, and cotton stalks and hulls. The extent to which feed costs were reduced by mixing molasses with other feeds depended largely on the size of feeding operations and the volume of bulk molasses that could be delivered at one time. Improved appearance of animals fed molasses was mentioned frequently by feeders as a reason for using it.

PORTER, W. F., AND METZLER, W. H. AVAILABILITY FOR EMPLOYMENT OF RURAL PEOPLE IN THE UPPER MONONGAHELA VALLEY, WEST VIRGINIA. W. Va. Agr. Expt. Sta. Bul. 391, 43 pp., illus. June 1956.

Of a sample of 2,287 persons 14 years of age and over, 16 percent were found to be either looking for work or potentially available for work at time of survey—at a time when the State ranked first in the percentage of insured workers who were unemployed. Nine in 10 of the workers preferred full-time nonfarm work. Few of those available had had any specialized vocational training but some had been employed in nonfarm work.

POWELL, J. V., AND BERBERICH, R. S. MARKETING TREE NUTS—TRENDS AND PROSPECTS. U. S. Dept. Agr. Mktg. Res. Rept. 139, 38 pp., illus. October 1956.

By 1975, consumption of tree nuts in this country is likely to exceed present supplies. With the rise in consumption, production is expected to increase. If per capita consumption of tree nuts remained at 1955 levels, population increases alone would insure an annual domestic consumption of over 300 million pounds, shelled basis, by 1975. However, per capita consumption is expected to increase because of improved marketing methods and greater consumer education concerning use of nuts.

REDMAN, JOHN C., AND OLSON, RUSSELL O. ECONOMIC PROBLEMS IN FEEDING DAIRY COWS. Ky. Agr. Expt. Sta. Bul. 648, 34 pp., illus. July 1956.

This report discusses the feeding problem in its theoretical framework; the technical relationships within the problem—substitution between feeds, diminishing returns to feed, price ratios, ascertaining the most profitable feeding system, and relation of other managerial problems to dairy-feeding decisions.

SHAFFER, PAUL, AND ANDERSON, DALE. UNLOADING AND RECEIVING PRODUCE IN RETAIL FOOD STORES. U. S. Dept. Agr. Mktg. Res. Rept. 129, 13 pp., illus. August 1956.

Researchers found that by using pallets, 163 cases of produce could be handled per man-hour. Only 56 could be handled when the cases were unloaded by hand and carried into the store on handtrucks. Comparisons were also made of 1- and 2-man crews unloading produce with and without conveyors. Production per man-hour is greater for the 1-man crew, but there are factors in favor of a 2-man crew. A separate watermelon-handling study evaluated 4 methods and types of equipment.

SHAFFER, PAUL, AND WISCHKAEMPER, PAUL. COST AND SALES RESULTS OF ALTERNATIVE METHODS OF HANDLING BANANAS AT RETAIL. U. S. Dept. Agr. AMS–149, 10 pp., illus. October 1956.

Analyzes five methods of preparing bananas at retail in terms of their effects upon labor costs, materials costs, and costs of consumer damage to bananas. Analyzes 2 of the 5 methods in terms of their effects upon sales volume. Data were collected in seven stores.

SMITH, H. V., AND HERRMANN, L. F. CHANGING PATTERNS IN FLUID MILK DISTRIBUTION: TYPES OF MILK, CHANNELS OF SALE, TYPES AND SIZES OF CONTAINERS. U. S. Dept. Agr. Mktg. Res. Rept. 135, 138 pp., illus. August 1956.

Milk distributors in many parts of the country are selling increasing proportions of their milk in half-gallon and gallon containers in place of quarts; in paper containers in place of glass. In nearly all the markets studied, homogenized milk was rapidly replacing regular milk. Milks to which vitamins have been added are generally homogenized.

STEWART, CLYDE E., AND HUFFMAN, ROY E. RESOURCE NEEDS AND INCOME POTENTIALS ON NEWLY IRRIGATED FAMILY-OPERATED FARMS, LOWER MARIAS PROJECT, MONTANA. Mont. Agr. Expt. Sta. Bul. 521, 90 pp., illus. June 1956. (Production Economics Research Branch, ARS, cooperating.)

Chief emphasis here is on the necessary resources and the incomes that may be expected under several methods of developing an irrigated farm. Five illustrative plans are analyzed and compared. All plans assume 150 acres of class 2 land, of which 140 acres are irrigated. Results on owner-operated farms suggest desirability of emphasizing cash crops in early years of development. Later, these crops may be replaced partly by a livestock enterprise.

TOOTHMAN, J. S. SURVEY OF DISTRIBUTION PRACTICES FOR PREPACKAGED FROZEN MEAT. U. S. Dept. Agr. Mktg. Res. Rept. 137, 23 pp., illus. September 1956.

Prepackaging meat at central locations may offer economies and merchandising advantages over methods now used in retail stores. Rapid sales growth of frozen meats and meat products emphasize the importance of expanding the facilities for processing and improving the methods of handling. To market the quantity of frozen red meat that trade observers estimate will be marketed within 5 years would require facilities for handling a pack equivalent to 75 percent of the 1955 commercial pack of all frozen foods.

U. S. AGRICULTURAL MARKETING SERVICE. CAPACITY OF REFRIGERATED WAREHOUSES IN THE UNITED STATES OCTOBER 1, 1955. U. S. Dept. Agr. Statis. Bul. 193, 35 pp., illus. October 1956.

On October 1, 1955, the national gross refrigerated capacity was 813 million cubic feet, an increase of 65 million cubic feet since the 1953 survey. The 10-year growth from 1945 to 1955 was 167 million cubic feet. Regional gains ranged from 114,000 cubic feet in the Mountain States to 20 million on the west coast.

U. S. AGRICULTURAL MARKETING SERVICE. FARM POPULATION—ESTIMATES FOR 1956. U. S. Dept. Agr. AMS–80 (1956), 10 pp. August 1956.

About 22,257,000 people lived on farms in the United States in April 1956—not far from the estimate for 1955. The drop in farm population continued the longtime down trend, reducing farm residents to 13.3 percent of the total population by 1956.

U. S. AGRICULTURAL MARKETING SERVICE. FEDERAL MILK MARKETING ORDERS—THEIR ESTABLISHMENT, TERMS, AND OPERATION. U. S. Dept. Agr. Misc. Pub. 732, 40 pp., illus. October 1956.

Effective application of the Federal milk order program depends upon free, full, and informed participation by all interested parties in the public proceedings which govern the orders. This report furnishes the needed information about Federal milk orders.

U. S. AGRICULTURAL MARKETING SERVICE. MARKETING COSTS AND MARGINS FOR FRESH MILK. U. S. Dept. Agr. Misc. Pub. 733, 15 pp., illus. October 1956.

The price paid by consumers for fresh milk went up about one-fifth from 1947 to 1955; the price received by farmers was about the same in both years. The higher price to consumers was due to increases in marketing costs—largely in payrolls, supplies, and equipment. Farmers received in 1955 only 45 cents of each dollar spent by consumers for fresh milk, and marketing charges were 55 cents.

VERMEER, JAMES. CHANGES IN COSTS ON SPRING WHEAT FARMS. U. S. Dept. Agr. Production Research Rept. 4, 39 pp., illus. September 1956.

Two groups of factors have had opposite effects on changes in costs on spring wheat farms since 1940. Continuously rising prices of goods and services used in production and the increasing proportion of these goods and services purchased from nonfarm sources have caused farm costs to rise at an accelerated rate. Conversely, larger farms and increased efficiency production through mechanization and other technological improvements have held down costs. Net effect has been an increase in cost per farm and costs per unit of production.

Statistical Compilations

U. S. AGRICULTURAL MARKETING SERVICE. FRUITS—NONCITRUS, BY STATES, 1949–55; REVISED ESTIMATES, UNITED STATES, 1934–55. PRODUCTION—USE—VALUE. U. S. Dept. Agr. Statis. Bul. 192, 88 pp. September 1956.

U. S. AGRICULTURAL MARKETING SERVICE. POTATOES—SWEETPOTATOES. REVISED ESTIMATES BY STATES 1949–55, ACREAGE, YIELD, PRODUCTION, PRICE AND VALUE, FARM DIPOSITION AND JANUARY 1 STOCKS. U. S. Dept. Agr. Statis. Bul. 190, 31 pp. August 1956.

U. S. AGRICULTURAL MARKETING SERVICE. PRODUCTION EXPENSES OF FARM OPERATORS, BY STATES, 1949–55. U. S. Dept. Agr. AMS–85 (revised 1956), 16 pp. October 1956.

U. S. AGRICULTURAL MARKETING SERVICE. PRODUCTION OF MANUFACTURED DAIRY PRODUCTS, 1955. U. S. Dept. Agr. Statis. Bul. 199, 42 pp. November 1956.

U. S. AGRICULTURAL MARKETING SERVICE. TREE NUTS, BY STATES, 1949–55—REVISED ESTIMATES, PRODUCTION, USE, VALUE. U. S. Dept. Agr. Statis. Bul. 195, 14 pp. October 1956.

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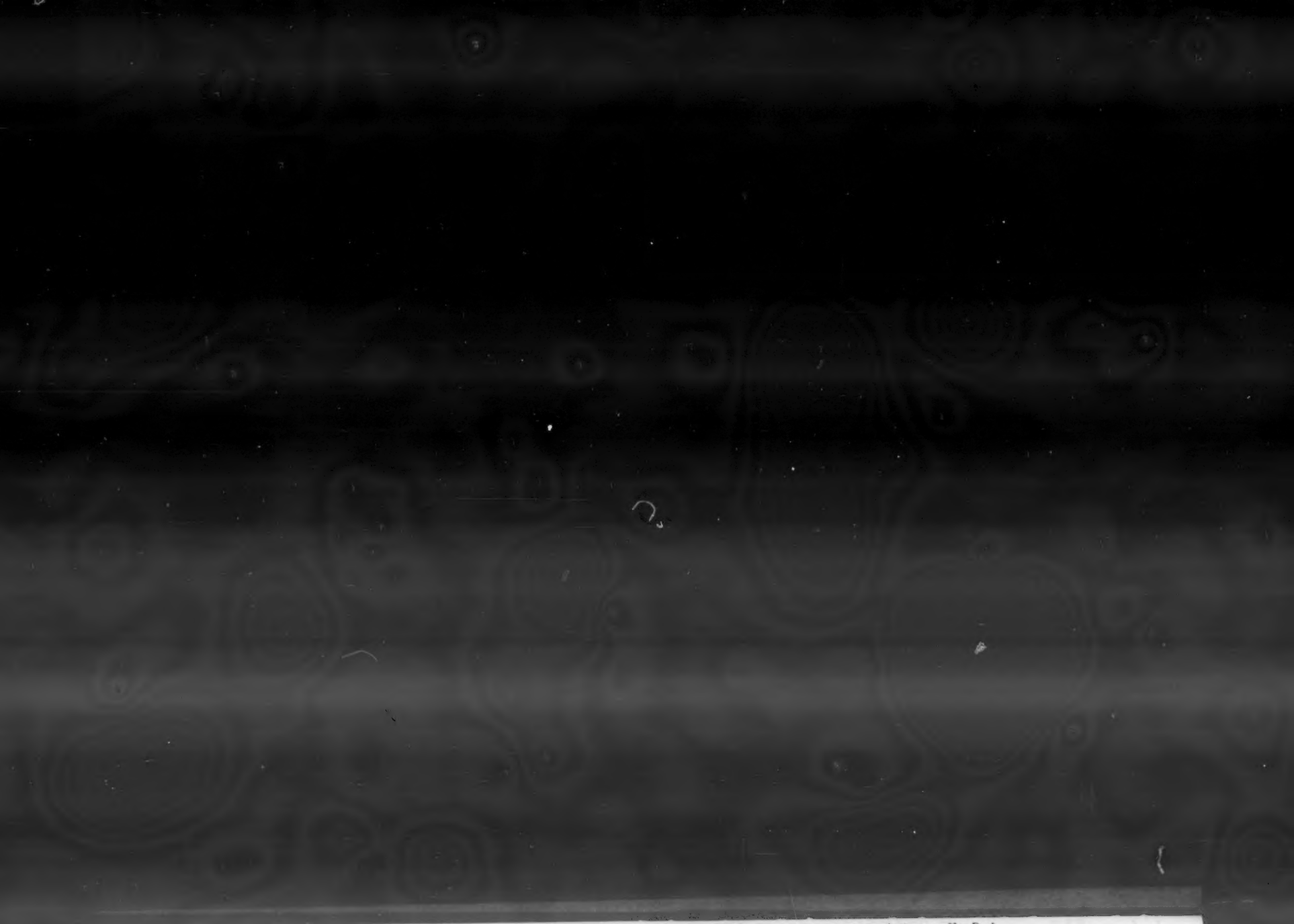

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